VOLUME 4 NUMBER 3 U.S JULY 1974

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NOAA is published quarterly by the Office of Public Affairs, National Oceanic and Atmospheric Administration, Rockville, Md. 20852, to acquaint readers with the policies and programs of the agency. The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through September 30, 1974.

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Annual subscription $5.70; $1.45 additional for foreign mailing. Single copy $1.45.

U.S. DEPARTMENT OF COMMERCE
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A Message From the Administrator

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Robert M. White

The U.S. Senate is launching a sweeping examination of the Nation's ocean programs.

Called the National Ocean Policy Study, its authorizing resolution was introduced by Sen. Warren G. Magnuson, Chairman of the Committee on Commerce; the study itself will be conducted under the chairmanship of Sen. Ernest F. Hollings, Chairman of the Commerce Committee's Subcommittee on Oceans and Atmosphere.

The two year effort will seek to:

—Determine current and prospective national oceanic capabilities,

—Determine the adequacy of current Federal programs relating to the oceans and recommend institutional, policy and legal improvements necessary to assure a strong and internationally competitive ocean policy and program,

—Establishing policies toward the full use and conservation of living resources, recommending solutions to problems in marine fisheries and their management, and other fisheries matters,

—Assess needs for policies for development and use of non-living resources, including the mineral resources of the Outer Continental Shelf and the deep seabed,

—Encourage implementation of coastal zone management through the coastal Zone Management Act of 1972 by assessing national growth policy needs, regional and interstate problems, State functions and powers in coastal zone management, and other related matters,

—Establish comprehensive national policy for understanding and protecting the global ocean environment,

—Make an assessment of proposals for, and current negotiations regarding the achievement of adequate national and international jurisdiction over the oceans, developing an understanding of the relationship of the oceans of the world order, and examining the United States' policy in that regard.

Needless to say, NOAA is deeply involved in all these concerns.

Under increasing pressure for food and mineral resources, and/or maintenance of a quality environment, the world is inevitably led to the seas for partial fulfillment, and to the Law of the Sea Conference of the United Nations in Caracas, Venezuela, to negotiate how the nations of the world can peacefully work out jurisdictions and obligations. Domestically we must also shape our policies and institutions to provide balanced, rational use of our resources to fulfill our national needs. The Senate Ocean Policy Study provides a unique forum and mechanism for deliberations, recommendations and action to these ends.

NOAA participation and effort is important to the study. And the study is vital to NOAA. It will receive our deepest and our fullest cooperation.

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Straight talk on a life-or-death issue from the man on the firing line

The Hard Facts About Hurricanes

By Dr. Neil Frank*

Where are we in our fight to protect the Nation against death and destruction from hurricanes?

We have learned a lot during the past several decades, and the death tolls from these superstorms have been drastically reduced. A number of significant events have contributed to this success.

World War II stimulated a renewed interest in tropical meteorology and the hurricane problem. In response an Institute of Tropical Meteorology was established on the Island of Puerto Rico in the early 1940's. Dr. Herbert Riehl and Gordon Dunn, former director of the National Hurricane Center, were two of the more renowned names associated with this Institute. Radar and hurricane reconnaissance were two other important by-products of World War II.

The National Hurricane Research Laboratory was created in 1956 as a result of several devastating hurricanes along the

Dr. Neil Frank is Director of NOAA's National Hurricane Center.

east coast. One of the primary achievements of this group was to purchase and instrument several aircraft, and data collected by these planes has greatly improved the hurricane forecasting process. Many of the techniques developed within the Laboratory are being used in the day-to-day operations at NHC.

The dawn of the satellite era in the early 1960's introduced a fascinating new observing concept in the tropics. Another landmark achievement was the development of the numerical storm surge model by Dr. Chester Jelesnianski in the latter part of the 1960's. A curve of our understanding of the hurricane phenomena shows a sharp rise over the last 35 years.

Looking to the future, we hope for significant improvements with the numerical models that are being developed. This summer a primitive equation hurricane model created by Dr. Banner Miller will be used for the first time. NOAA's National Weather Service and the National Hurricane Research Laboratory are collaborating in the development of a multi-level

On a normal summer day, one million people flock to Southern New Jersey Beaches. Only one road out . . . handles 4,500 cars per hour.

sophisticated baroclinic model, and the first generation of the new model should be ready for testing this summer.

We are blessed with unprecedented satellite coverage and the new GOES system will provide important new dimensions to weather observations.

Further downstream, Project Stormfury has given man hope that the hurricane's fury can be blunted through weather modification.

Thanks to weather satellites, radar, aircraft reconnaissance, and constant improvement in forecast techniques, the U.S. has the best warning service in the world.

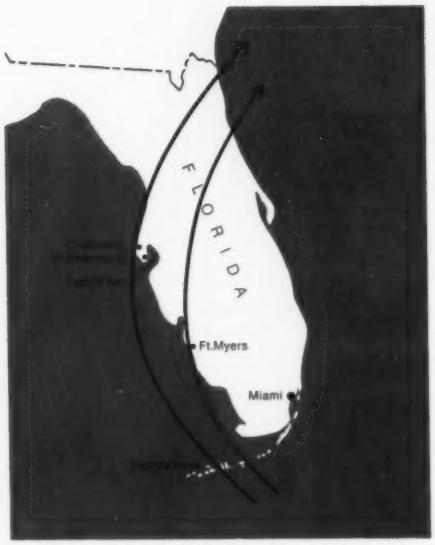
So far the picture appears to be bright. Now let me explore the spectre that haunts every hurricane forecaster.

The richness and beauty of the American coastline has attracted millions of persons.

During the period 1960-1970 the U.S. as a whole has shown a population increase of 12 percent. According to a recent University of Colorado study, beach residents along the Atlantic and Gulf coasts have increased by more than 40 percent during this same period.

In almost every Atlantic and Gulf coast state one can observe a shift of people to the coast. In Texas, for example, in the early part of this century less than 10 percent of the people lived on the coast. Today, one-fourth of Texas residents live in coastal areas.

This trend to the coast—to the beaches—raises a most important and sobering question. What is the hurricane experience level of our coastal residents? Millions of coastline dwellers or visitors from Brownsville, Texas to Eastport, Maine have never experienced a major hurricane or even had a brush with the inner core of a lesser storm. Extreme devastation in a very big hurricane is limited to a very small area, and even in the most severe hurricanes that devastation seldom spreads over more than 50 miles of coastline.



About 150 miles of Florida coast would have been devastated if Donna followed other path.

It is important to distinguish between a "direct hit" and "fringe" experience. Most of the people who go through a hurricane experience fringe conditions. Less than 25 percent actually witness the core region. This breeds potential disaster because it lulls those who passed through the fringes to a false sense of complacency for the next time. It's difficult to convince them that conditions a few miles away could have been deadly.

The disaster scale defines five classes of hurricanes according to maximum winds, central pressure, storm surge, and damages. The top of the scale corresponds to a Camille-type storm while at the bottom is a minimal hurricane. There have been only two Number 5 hurricane landfalls this century—Camille along the Mississippi coast and the 1935 hurricane that killed more than 400 persons in the Florida Keys.

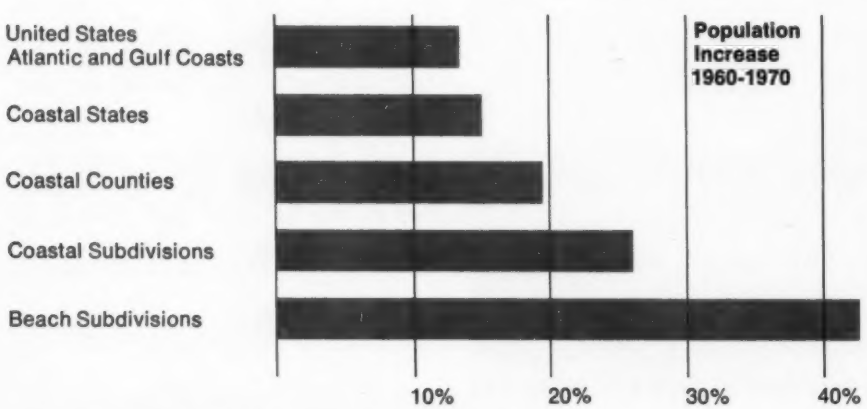
To gage the level of hurricane experience in several coastal counties we arbitrarily decided to find out what percentage of the coastal population had experienced a direct hit by a moderately strong storm (Category 3 or stronger).

Broward County, Florida, just north of Miami, has one of the highest growth rates in the nation. Six thousand new residents are moving there each month and the population is nearing one million. In 1965, Broward County was brushed by Hurricane Betsy; experienced a direct hit by weak hurricanes in 1964 and 1950 and was on the distant fringe of Donna in 1960. The last direct hit in Broward by a "3" type storm was in 1947. At that time the population was less than 100,000. Today, nearly 90 percent of Broward County's million residents just don't know what a strong hurricane was all about. The weak ones and the fringe experiences have lulled many into a state of apathy.

In Dade County, Florida, where Miami is located, one and a half million people (75 percent of the population) are in the same status. Farther north in West Palm Beach County, another quarter of a million can be added to our inexperienced group. The southeast Florida coast is one of the most hurricane vulnerable sections of the U.S. with an expected hurricane frequency of one every seven years. If we total the inexperience among these three counties we find over two and a half million people. This represents over 80 percent of the people along the Gold Coast.

On the west coast of Florida there are similar situations. In Pinella County, where Clearwater and St. Petersburg are located, the last direct hit by a hurricane was in 1921. The population then was less than 30,000. Today there are half a million people there and the population is escalating.

The problem of no hurricane experience and the influx of people to the coastal and beach areas is by no means confined to Florida. Suffolk County in New York covers the eastern two thirds of Long Island. The last time a "3" storm caused severe damage to that county was in 1960 with the passage of Hurricane Donna. The population at that time was 600,000. Today 1,200,000 live in Suffolk County. If you add Nassau, Queens and Bronx Counties, which comprise the remainder of Long Island, you have 5,500,000 people who have no or little familiarity with life-threatening hurricanes.



Source: The Institute of Behavioral Science, University of Colorado

Hurricane Disaster-Potential Scale:

The hurricane disaster-potential scale is an experimental effort by the National Weather Service to give public safety officials a continuing assessment of the potential for wind and storm-surge damage from a hurricane after it reaches a point where it could be a threat to their coastal populations.

Scale numbers are made available to public-safety officials when a hurricane is within 72 hours of landfall.

Scale numbers range from 1 to 5—with Scale No. 1 having at least the threshold windspeed of a hurricane of 74 miles per hour, or a storm surge 4 to 5 feet above normal water level—and Scale No. 5 having a windspeed of 155 miles per hour or more, or a storm surge more than 18 feet above normal.

The Weather Service emphasizes that the disaster-potential numbers are not forecasts, but will be based on observed conditions at a given time in a hurricane's lifespan. They represent an estimate of what the storm would do to a coastal area if it were to strike without change in destructive power. Scale assessments will be revised regularly as new observations are made, and public-safety organizations will be continually advised of new estimates of the hurricane's disaster potential.

The Disaster-Potential Scale gives probable property damage and evacuation recommendations as follows:

Scale No. 1—Winds of 74 to 95 miles per hour. Damage primarily to shrubbery, trees, foliage and unanchored mobile homes. No real damage to other structures. Some damage to poorly constructed signs. Or: storm surge 4 to 5 feet above normal. Low-lying coastal roads inundated, minor pier damage, some small craft in exposed anchorages torn from moorings.

Scale No. 2—Winds of 96 to 110 miles per hour. Considerable damage to shrubbery and tree foliage, some trees blown down. Major damage to exposed mobile homes. Extensive damage to poorly constructed signs. Some damage to roofing materials of buildings; some window and door damage. No major damage to buildings. Or: storm surge 6 to 8 feet above normal. Coastal roads and low-lying escape routes inland cut by rising water 2 to 4 hours before arrival of hurricane center. Considerable damage to piers. Marinas flooded. Small craft in unprotected anchorages torn from moorings. Evacuation of some shoreline residences and low-lying island areas required.

Scale No. 3—Winds of 111 to 130 miles per hour. Foliage torn from trees, large trees blown down. Practically all poorly constructed signs blown down. Some damage to roofing materials of buildings; some window and door damage. Some structural damage to small buildings. Mobile homes destroyed. Or: storm surge 9 to 12 feet above normal. Serious flooding at coast and many smaller structures near coast destroyed; larger structures near coast damaged by battering waves and floating debris. Low-lying escape routes inland cut by rising water 3 to 5 hours before hurricane center arrives. Flat terrain 5 feet or less above sea level flooded inland 8 miles or more. Evacuation of low-lying residences within several blocks of shoreline possibly required.

Scale No. 4—Winds of 131 to 155 miles per hour. Shrubs and trees blown down, all signs down. Extensive damage to roofing materials, windows and doors. Complete failure of roofs on many small residences. Complete destruction of mobile homes. Or: storm surge 13 to 18 feet above normal. Flat terrain 10 feet or less above sea level flooded inland as far as 6 miles. Major damage to lower floors of structures near shore due to flooding and battering by waves and floating debris. Low-lying escape routes inland cut by rising water 3 to 5 hours before hurricane center arrives. Major erosion of beaches. Massive evacuation of all residences within 500 yards of shore possibly required, and of single-story residences on low ground within 2 miles of shore.

Scale No. 5—Winds greater than 155 miles per hour. Shrubs and trees blown down, considerable damage to roofs of buildings; all signs down. Very severe and extensive damage to windows and doors. Complete failure of roofs on many residences and industrial buildings. Extensive shattering of glass in windows and doors. Some complete building failures. Small buildings overturned or blown away. Complete destruction of mobile homes. Or: storm surge greater than 18 feet above normal. Major damage to lower floors of all structures less than 15 feet above sea level within 500 yards of shore. Low-lying escape routes inland cut by rising water 3 to 5 hours before hurricane center arrives. Massive evacuation of residential areas on low ground within 5 to 10 miles of shore possibly required.

Definition of the Scale

Category	Central Pressure (millibars)	Winds (mph)	Surge (ft)	Example
1	>980	74-95	4-5	Agnes 1972 (Fla. coast)
2	965-979	96-110	6-8	Cleo 1964
3	945-964	111-130	9-12	Betsy 1965
4	920-944	131-155	13-18	Donna 1960 Fla., Carla 1961 Tex.
5	<920	>155	>18	1935 Storm on Fla. Keys

The storm surge is the big killer. An informed coastal population is of vital concern to NWS.

Washington Star Photo: John Bowden

The coast of New Jersey illustrates another aspect of the problem. Cape May County is the southernmost county in New Jersey, and most of the residents of this county live in small communities on the off-shore Islands. Cape May County has been brushed by several strong storms, but it has escaped a direct hit in recent years. The unique problem in Cape May County is associated with the summer tourists. While the permanent population is only 60,000, this may increase by a factor of 10 on a normal summer day and can escalate to one million on a summer weekend. There is only one road out of Southern New Jersey, and traffic experts estimate this will handle about 4,500 cars per hour.

In the Atlantic and Gulf coastal areas of the nation, it is sobering indeed to contemplate that 60 percent of the residents are inexperienced—31 million out of 35 million. Along the West Gulf Coast the experience level is very high because of recent strong and numerous Gulf storms —Celia in 1970; Camille in 1969; Beulah in 1967; Betsy in 1965; Hilda in 1964, and Carla in 1961—but during this same period there was not one severe storm along the east coast of the United States.

The higher probability of an extreme storm south of latitude 30° North makes Florida's problems very critical. Complicating the threat is the fact that Florida's coastal population is located on low ground, subject to extreme flooding by a large storm surge. The magnitude of this problem can be illustrated by considering what would have happened on the Florida West Coast if Donna in 1960 had followed the forecast track. The forecast suggested Donna would stay offshore and eventually move inland over Tampa Bay. What kind of a storm surge would residents along the Florida West Coast have experienced had Donna moved along the predicted track? Fortunately, we can simulate what could have happened using Jelesnianski's storm surge model.

The results are awesome. More than 150 miles of the Florida West Coast from Ft. Myers to Clearwater would have been devastated by a surge in excess of ten feet, and around Tampa Bay the water depths would have been greater than 15 feet, according to this model. Over a million people live along that portion of the coast and their hurricane experience level is almost zero.

Two other problems are related to the increasing coastal population. We are rapidly approaching the time when it will no longer be economically realistic to take precautions over as wide a coastline as we have in the past. A hurricane warning over Long Island involves five and a half million people, and the cost of buttoning up New York would be staggering. During the past 15 years the average size of the warning area for major hurricanes was 275 miles. The extremes ranged up to 400 miles in Betsy (1965) and Carla (1961). The coastal population crunch places a heavy burden on our research effort to develop new ways of improving the forecast tracks and reduce the number of people who are overwarned.

Another matter of vital importance con-

County Population By State

(Coastal Counties)

State	1970	At last [1] major hurricane	Increase	Percent to 1970 total
Texas	2,899,895	2,362,466	537,429	18.5
Louisiana	1,385,438	1,145,440	239,998	17.3
Mississippi	239,944	167,463	72,481	30.2
Alabama	376,690	136,330	240,360	63.8
Florida	5,388,107	1,667,304	3,720,803	69.1
Georgia	281,108		281,108	100.0
S. Carolina	429,900	377,764	52,226	12.1
N. Carolina	414,850	380,930	33,920	8.2
Virginia	674,068		674,068	100.0
Maryland	1,357,393		1,357,393	100.0
Delaware	548,104		548,104	100.0
New Jersey	3,498,389		3,498,389	100.0
New York	9,802,763	2,984,651	6,818,112	69.6
Connecticut	1,882,926	1,071,157	811,769	43.1
Rhode Island	946,725	744,766	201,959	21.3
Massachusetts	2,862,290	1,838,913	1,023,377	35.8
New Hampshire	138,951		138,951	100.0
Maine	464,883		464,883	100.0
All	33,592,424		20,715,330	61.7

[1] State totals are based on individual county populations at time of last major hurricane (different years).

Coastal population which has never experienced a direct hit by a major hurricane. The 1970 population total was used when the last major hurricane was prior to 1900.

cerns safety actions that must be taken by coastal residents. Historically the primary way of seeking safety from the storm surge has been to flee inland—by auto. But traffic engineers tell us that the road systems will not handle the volume of traffic to evacuate many of our beach developments. A case in point is the summer tourist traffic along the Southern New Jersey shore. Another vulnerable area is the Florida Keys served by a narrow, two lane road with numerous marginal beaches.

This past spring a truck hit one of the drawbridges in the Keys and tied up traffic for over seven hours.

What if this occurred during a hurricane when thousands of people were fleeing to the mainland for protection?

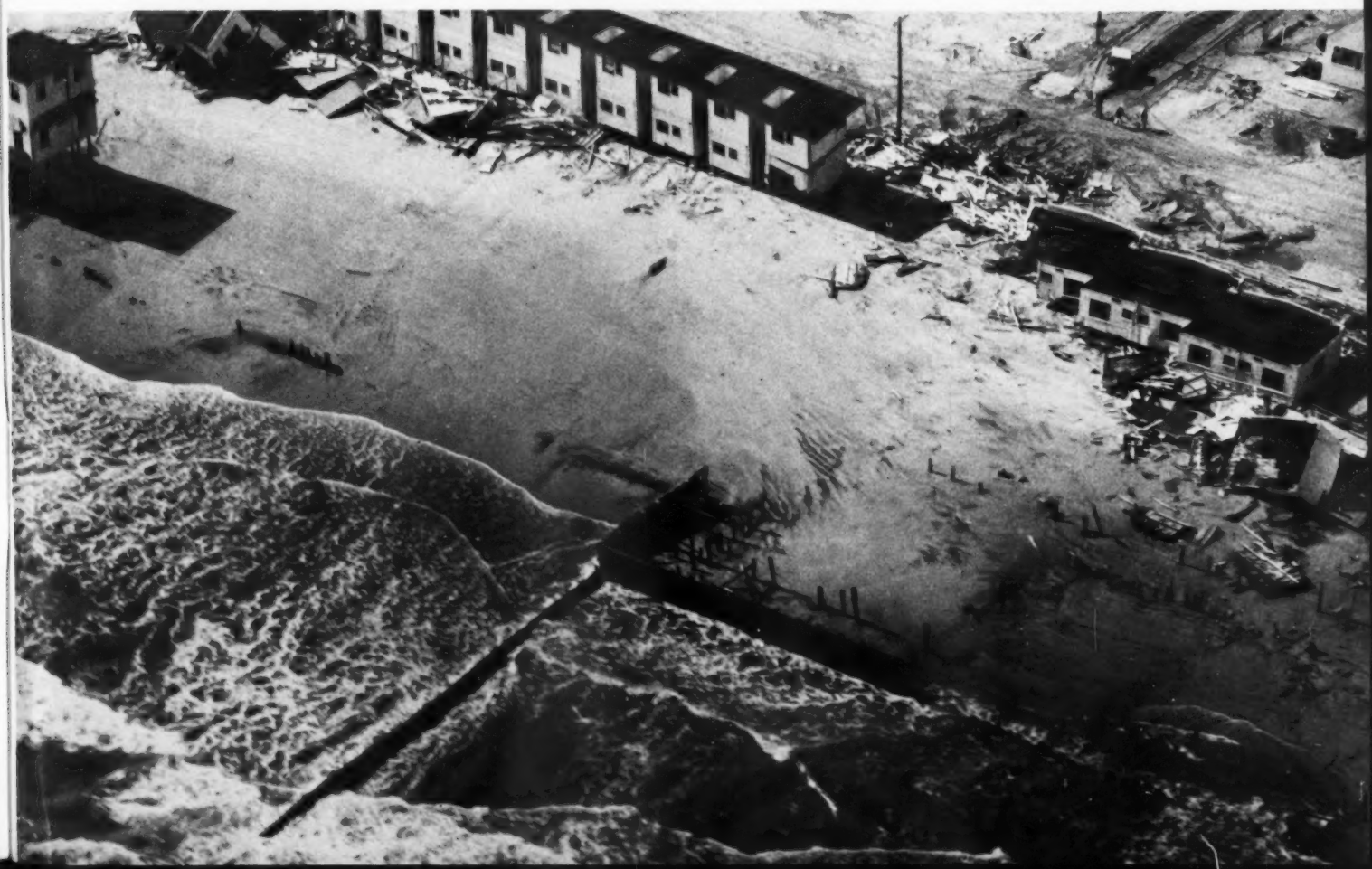
Are there reasonable alternatives to horizontal evacuation? We have suggested that local government officials in Dade County might consider the use of substantial multi-level buildings as places of safety. In locations where there are a large number of highrises, apartments, and condominiums, these could be designated as vertical refuges, and people could seek shelter by moving vertically rather than horizontally.

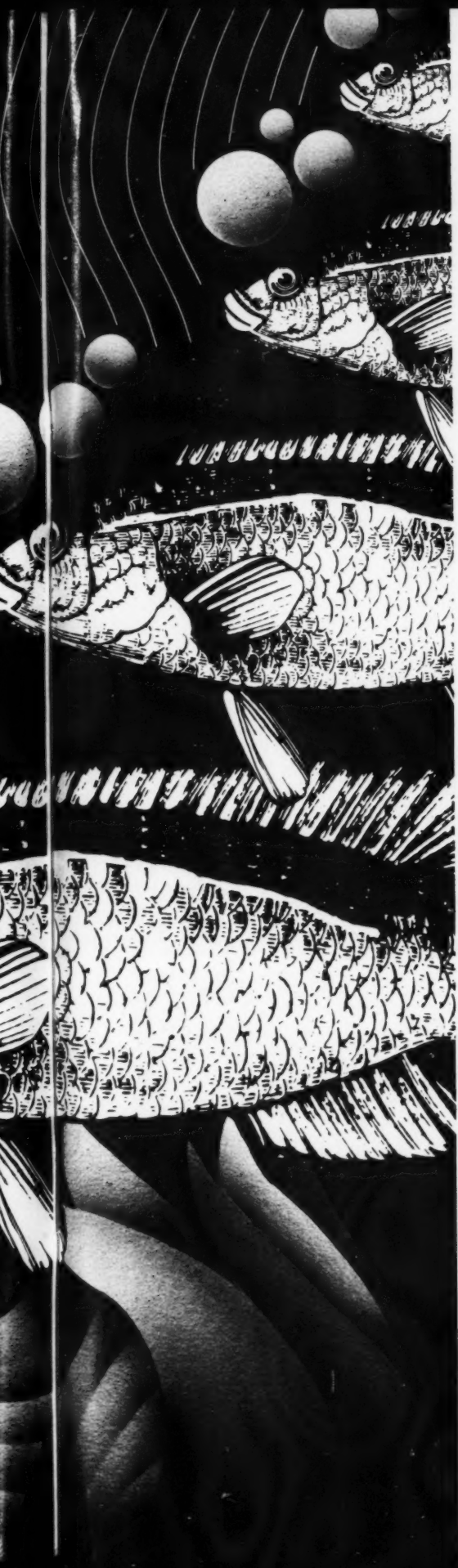
This has a very attractive feature for the Hurricane Warning Service. If we knew everyone could relocate to a vertical refuge within a few hours, we could restrict the area warned and greatly reduce the size of the evacuation area.

One of the key issues associated with hurricane warnings is the growing uninformed coastal population. We have reached a plateau in hurricane forecasting, and the real hope for significant improvements rests with the success of numerical models. The fruit of this effort may not be realized for several years. In the meantime I believe there can be important short-term payoffs in the way we market our product—the forecast and warning. We must deal with the consumer —the people—and substitute education for experience. We must become more acquainted with our "customers" and learn how to stimulate them to action. All too often we have decreed what the customer needed rather than sought to understand his problems. Human behavior is extremely complex (and in some cases even more difficult to predict than the weather) but if our product is to become more effective, we must tailor it to the individual.

It is time to launch a grassroots community-and-individual public awareness program.

A hurricane warning over Long Island involves five and a half million people.





Studying heat effluent effects on fish, Sea Grant scientists use

The Thermal Telescope

BY WARREN DOWNS *

"Four miles to the flight line." The pilot's announcement crackles briefly over the intercom. At the rear of the plane, Bob Madding, a research physicist from the University of Wisconsin-Madison, glances over a small panel of buttons, dials and switches. Adjusting a control, he subdues a manic dance of green lines on an oscilloscope to a quivering contour.

Madding cups a mike to his mouth to speak over the drone of the twin-prop engines as the plane turns into a flight line that follows the Lake Michigan coast.

"110 knots ground speed—make that 125," the pilot replies over the intercom. Madding flips over indexed pages in a worm notebook, enters the correct speed, the name of the targeted power plant, the date and the time.

By this time his glances fasten on the oscilloscope. The green line begins to arch up, like an agitated inch-worm.

"There it is." He nods at the profile. "There's your plume."

* * *

The "plumes" targeted for this flight are discharges of heated water, fanning out into Lake Michigan from some half-dozen electric power plants along the Wisconsin coast.

For several years, these discharges have come under the systematic scrutiny of a small team of scientists at UW-Madison supported by NOAA's National Sea Grant Program. Almost 70 times this year they have flown a lumbering DC-3 airplane, bearing their scientific gear, up and down the Lake Michigan coastline. From Kenosha to Green Bay they have been measuring the shape, flow and temperature of these all but invisible plumes.

"This phenomenon of hot water entering our lakes and rivers is fairly widespread," says Theodore Green, professor of civil engineering and meteorology and co-director of the thermal plume project. "Wisconsin alone has seven major power plants on Lake Michigan, each of which takes enormous quantities of water to cool their condensors. The plants then discharge this water, which is up to 20°F hotter than the receiving lake waters."

Green and co-director Frank Scarpace of the University's Marine Studies Center have believed from the outset that it is important to find out what these rivers of heated water are doing to the lake. They note that there are an additional 17 power plants planned or in operation elsewhere around Lake Michigan.

Their research so far has concentrated on the Point Beach nuclear power plant as a useful model for many others. Each minute, 700,000 gallons of hot water pour into Lake Michigan from the plant's twin outfalls. The scientists want to know where and how fast this effluent goes, how deep it is, and what the temperatures are at various points in the plume.

To study something that is not only invisible to the unaided eye but is also subject to the whims of winds, currents and waves, the scientists have adapted a technique developed for military reconnaissance. "Remote sensing," as the term implies, depends on survey instruments sensitive enough to be used at great distances—from airplanes or satellites.

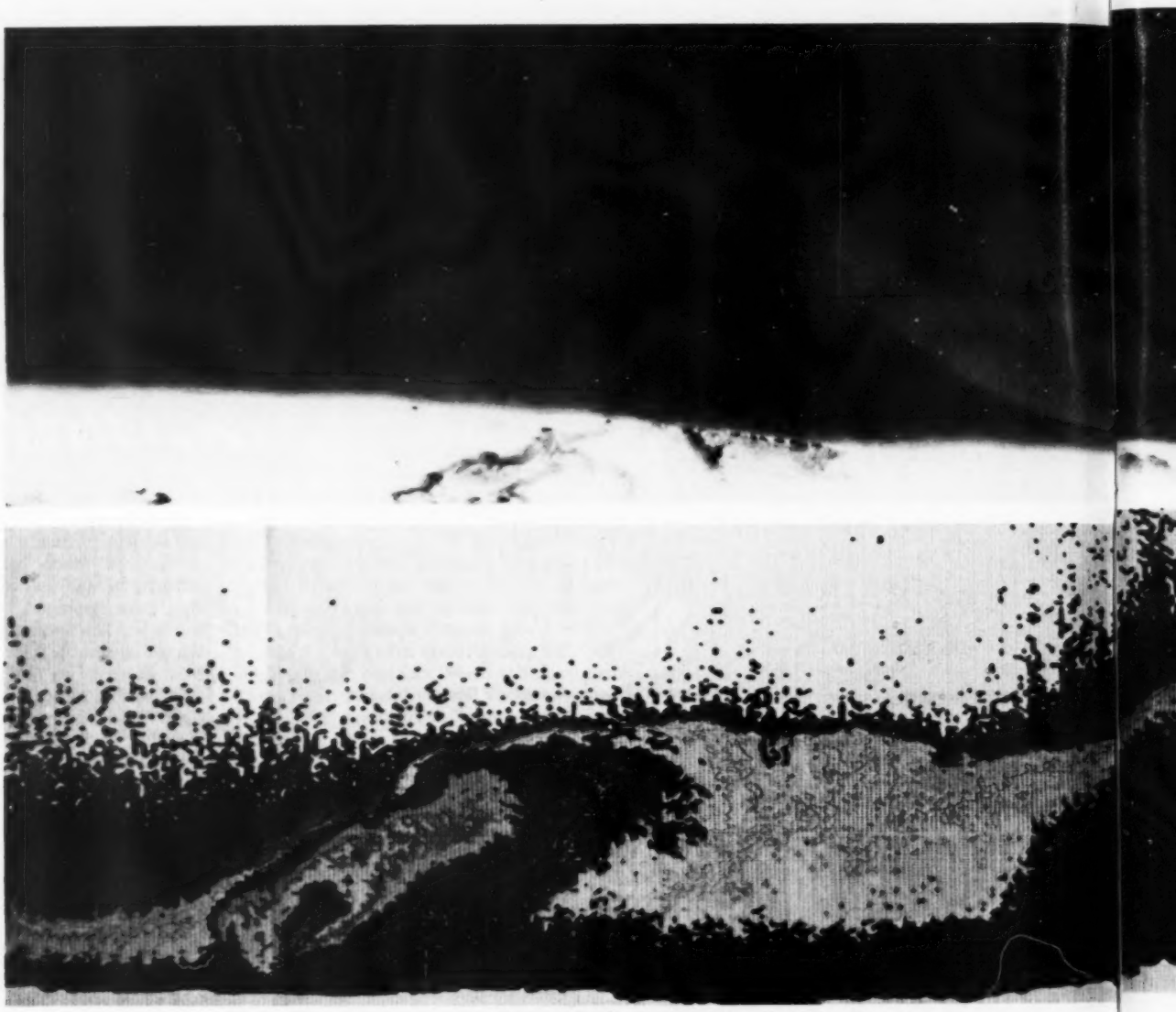
The essential instrument being used by the UW scientists is a "thermal scanner," a 25-inch long cigar-shaped instrument that is attached to the belly of the plane. A mirror in its center whirls 5,000 times per minute, registering the long-wave radiation from the earth's surface below. Roughly approximate to the heat being given off from the earth, this radiation then reveals a kind of thermal map of the area to the investigators.

The process, however, is more exacting than that would imply. Each revolution of this 4-inch eye-in-the-sky sweeps a narrow path directly below, whose length extends up to a mile to either side, depending on the elevation of the plane. Depending on cloud conditions, this elevation may vary between 3,000 and 5,000 feet.

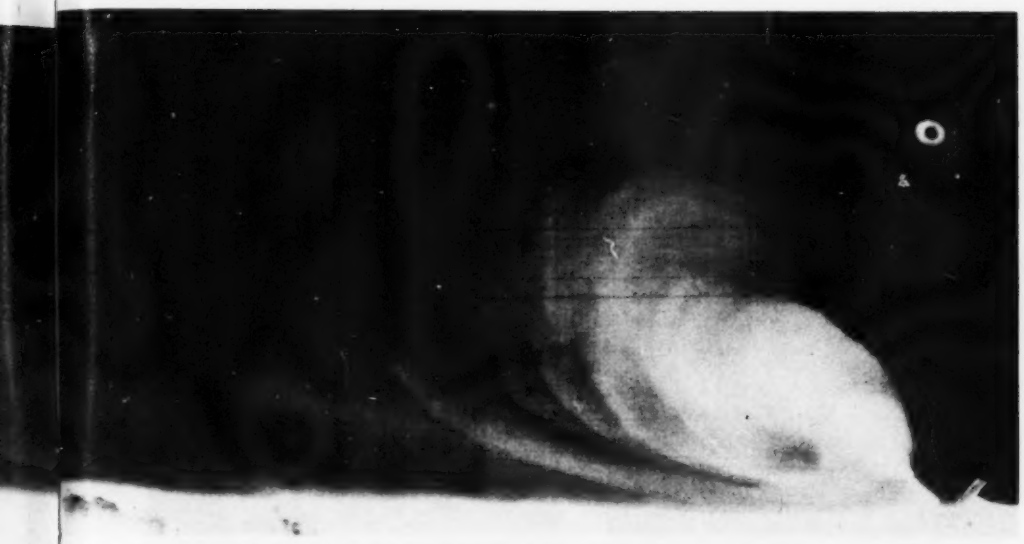
These linear impressions, recorded on FM wide-band tape inside the plane, can then be processed as a pattern of numbers on a large chart. Or they can be stacked like thin wafers, whose edges form on film the elongated thermal "picture" of surfaces below.

"It's similar in principle to TV reception," explains Madding. "It consists of the same rapid sweep of electronic im-

* *Warren Downs is Assistant Editor, University of Wisconsin Sea Grant Program.*



Thermal plume of the Point Beach (Wisconsin) nuclear power plant, measured in March 1973 by Wisconsin Sea Grant's remote sensing scanner attached to the belly of a DC-3. Top photo obtained by the thermal scanner shows the evolution of the thermal fronts. The intake crib for the plant's coolant water appear as a white annular spot, and is 534 meters offshore in Lake Michigan. From this thermal picture, the digitized form shown in lower strip is derived. The digitized form is used with a color-coded legend for easier interpretation, providing specific temperatures throughout the area. These digitized maps can then be processed to show the thermal plume's surface isotherms, as in the diagram at right. The left edge of the plume reveals the relatively steep temperature gradient encountered by fish entering or leaving the plume on the upwind side.



pressions running horizontally across the screen. With our scanner we can get the vertical dimension through the forward travel of the plane."

On film the plumes appear dramatically as white billowing images that darken as they cool down to the ambient temperature of the lake near their forward edges. However, the filmed imagery does not show the actual water temperatures.

For this essential "ground truth," technicians at each power plant being monitored must actually go out and poke thermometers into the water. These temperatures, taken at prescribed locations, must coincide with the scanner's trips overhead. This data is then sent into project headquarters in Madison where it is coordinated with the plume pictures.

This kind of cooperation at all levels has, in fact, been the linchpin in mounting an undertaking of this magnitude.

Three electric utilities — Wisconsin Electric Power, Wisconsin Public Service and Wisconsin Power and Light—have financed part of the project, including the purchase of the thermal scanner, one of a handful in use around the country.

The Wisconsin Department of Natural Resources (DNR) has supplied the airplane and pilot, and financial support has come from NOAA through the University of Wisconsin Sea Grant College Program, and from the National Science Foundation.

By pooling their resources, the scientists, the utilities and the federal and state agencies feel they have come out ahead.

Kenneth Lehner, director of environmental activities for Wisconsin Electric Power Company, notes that the data from Green's thermal scanning of their Point Beach plant has already been incorporated into the utility's recent environmental report to the DNR.

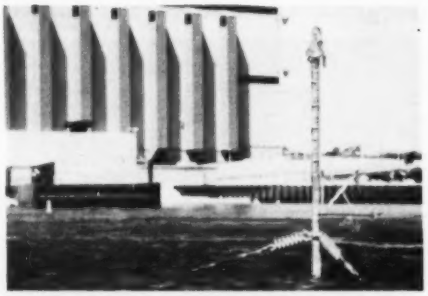
Pat Schraufnagel, chief of the DNR's Bureau of Standards and Surveys, remarks on the efficiency of thermal imagery, which can detect a plume "in one fell swoop instead of piecing together a picture from scattered measurements taken from a boat." Information on the structure and dynamics of thermal discharges, says Schraufnagel, will enable the Department to establish limits and legal requirements for the mixing zones of heated water in Lake Michigan.

The scientists see broader implications in their research. "In a sense we're not just studying artificial plumes," says Green. "We can generalize this information to any river that is warmer than the lake which it enters."

Such information would be useful, thereby, in understanding the dispersion of the river's pollutants. The scientists' initial observations have already yielded significant features of thermal plumes not heretofore revealed in laboratory or theoretical experiments.

Zoologist John Magnuson and assistant Tom Beitinger inspect divided fish tanks at Wisconsin's Limnology Laboratory, where blackout enclosure and temperature controls permit simulation of day and night conditions. At right, physicist Bob Madding injects liquid nitrogen into thermal scanner's mercury cadmium telluride detector, before flight.

Temperature-monitoring pole 122 meters off the Point Beach nuclear plant provides "ground truth" check on temperature data obtained by airborne scanner. At left, adjustments are made to the pole, firmly guyed in five meters of water.



For one, they reveal that plumes drift further than expected—up to four or five miles on occasion. For another, many plumes (about one-sixth of those observed) show a characteristic scalloped formation, marked by a series of concentric thermal fronts some 200 feet apart radiating from the outfall. Tests reveal water temperatures drop up to 5°F along the sharp forward edges of these thermal waves. As yet the scientists cannot explain what causes these themal waves or their effects.

"In winter, on the other hand, your plume might be 'taking a dive'," Madding says, explaining that as the plume cools to about 39°F it becomes heavier than the near-freezing water on which it is floating. As a result, the cooling plume can suddenly lose its buoyancy in winter and sink from sight.

"Our scanner can't monitor these dives because it only measures surface heat," Madding says. "But if the scanner shows an abrupt edge to the plume under these temperature conditions, then you can suspect a diving plume."

Despite such curious features, the physical study of thermal plumes alone cannot explain their effect on fish and plant life in the area. So, a team of UW-Madison biologists is doing related research to try to answer these questions.

According to project leader John Magnuson, a zoologist at UW-Madison's Laboratory of Limnology, each species of fish seeks a preferred temperature.

"If the animal prefers warmer water than the ambient temperature of the lake, then it will tend to move into a plume because it will be closer to that desired temperature," Magnuson says. "But we don't have a handle yet on how the stepwise gradients, noticed by Green's team, influence the fish."

Although fish, being cold blooded, are much more vulnerable to temperatures than warm blooded animals, Magnuson says they have found no real evidence of thermal deaths among fish at Point Beach.

"But we are concerned about the plume's long-term effects on disease, growth, reproduction and vigor," he says.

In the laboratory, Magnuson's research group is attempting to supplement what is being done in the field by running experiments to determine the temperatures fish prefer and the extremes—hot or cold—they avoid.

For this, they are using a set of tanks in which the fish itself can control the temperature in a four-day test period. The experimental fish—usually a bluegill or coho salmon—can swim through a tunnel from one side of its small divided tank to the other where the water is 2°C warmer.

When it does this, temperatures in both parts of the tank start to rise at the rate of 3°C per hour. Eventually, the fish must swim back for relief to the cooler side, tripping a switch and causing temperatures to start dropping slowly at the same rate.

Every six minutes the tank temperatures are automatically recorded while photo-cells in the tank tunnel register each passage of the fish. The number of such recorded passages over time gives some measure of fish activity. Laboratory lighting that simulates day, dusk and night is an added variable in the experiment.

In monitoring the experiment, research assistant Tom Beitinger has come to the opinion that bluegill are "fantastic fish—very intelligent and curious." His records show that bluegill have readily adapted to the laboratory setup, keeping their tanks between 29 and 33°C.

In contrast, Beitinger finds that while coho regulate tank temperatures very well during the day, at night they will go to the cooler side and let the temperature slide down to the system's minimum level—3°C.

"They just sit there and refuse to play the game anymore," says Beitinger. "Not until daylight will they take temperatures up around 18°C and then go back and forth to maintain this warmer level."

Such behavior over time can be readily observed with this experimental setup —which records specific responses to a constantly changing thermal and photic environment. This contrasts with the classic experimental approach, in which fish are allowed to seek out their preferred temperature in a large tank with a fixed gradient of water temperatures.

To place such data in a realistic setting, Magnuson's team is also working in the waters off the Point Beach plant. They take a small research vessel through the plume, using sonar devices to detect the number and distribution of fish in the heated water. Gill nets and trawls are also used to bring up samples of the kinds of fish present.

Summer samplings have turned up mostly alewives and very small numbers of lake, brown and rainbow trout and carp in the plume's waters.

The scientists ultimately plan to attach radio transmitters to some of the fish in the plume area and track them to learn whether they are transient or permanent residents. Magnuson believes this question is important because one mathematical study indicates that if fish did remain in the plume throughout the summer, they would grow more slowly than their counterparts in the lake, despite the greater abundance of food flowing in these heated currents.

Some fish tracking has already been done with migrating salmon to determine what behavioral changes, if any, occur when these fish encounter the discharges of heated water found in these regions.

For this purpose a research team under the direction of limnologist Arthur Hasler has removed salmon from their home stream, 30 miles north of the Point Beach plant. The scientists then tagged the fish with small, ultrasonic transmitters and released them just south of the power plant.

In following the salmon's signals, the scientists found that most of the salmon migrated back north as expected. However, upon reaching the heated discharge from the Point Beach plant, most of the salmon repeatedly turned back or veered at right angles to circumvent the plume. Fish migrating further out from shore were able to swim under the heated water which floats in a thin layer on top of the colder lake waters.

Early tracks were plagued by electronic failures. But the transmitters, now reduced to the size of a fat cigarette, have grown in sophistication and reliability. In addition to locating and tracking the fish, the beeps, in their varied rapidity, now can reveal the water temperatures being encountered by the fish. In future tests, the pitch of the signal will also indicate pressure used as a measure of the fish's swimming depth.

"For fish who migrate close to shore, the currents of a thermal plume might be confusing and disrupt their migration," says fish tracker Ross Horrall, associate scientist in the University's Marine Studies Center. "This could be critical if the fish are heading for their spawning grounds—like the taxi that is stalled or takes the wrong turn on the way to the maternity ward."

As biological and behavioral studies of the fish continue, the scientists working on the physical characteristics of plumes have uncovered few discernable effects at Point Beach.

However, project director Green believes no one can yet be sure about long-term effects. "Eventually there should be a 'formula' that tells us whether a plume is innocent or harmful," he says.

Rather than the traditional standard of the effluent's "mixing zone" in the lake, Green suggests that more realistic factors in the formula might be surface temperature at a point in a plume times its distance from the outfall, or perhaps the steepness of the thermal gradient—in effect, how quickly the temperatures rise as the fish swims into the plume.

"We're a long way from correlating such parameters with a plume's impact, but that's what we must point toward," says Green. "At the same time, these things should be couched in terms of what you can measure easily."

For instance, Green maintains that if the necessary correlations between surface and subsurface temperatures can be established, then thermal standards could be written in more practical terms of surface temperatures, and thus avoid the great difficulties of subsurface sampling.

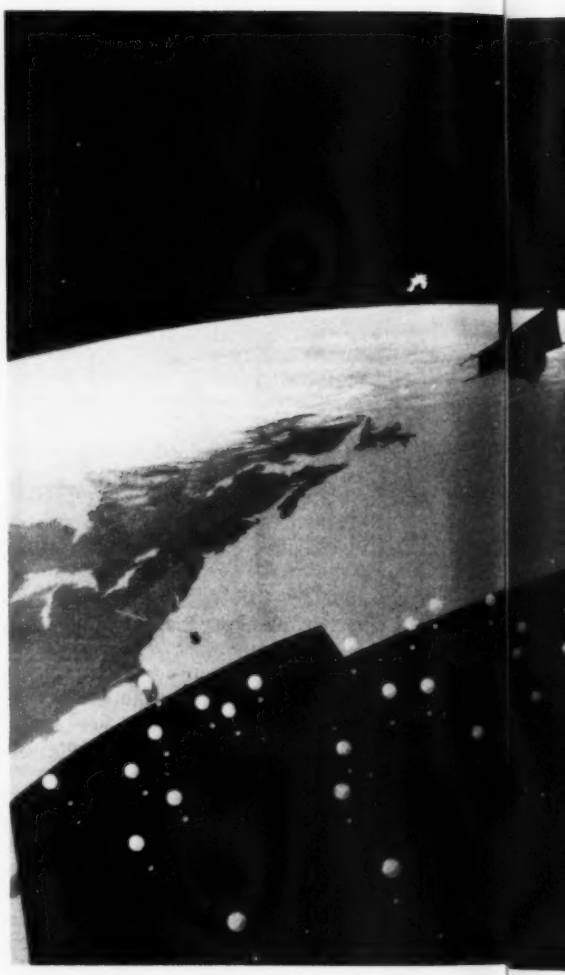
With more and more heated water pouring into the Great Lakes system, Wisconsin's Sea Grant scientists believe remote sensing will emerge as a ready-made answer to monitoring problems.

"I don't see any other way coming down the pike for getting a true, instantaneous 'snapshot' of the surface features of these plumes," says Green.

If this view is accepted by the Great Lakes states, the Environmental Protection Agency, industries and other groups, remote sensing of the entire Great Lakes shoreline by airplane could be in the wings.

With 5,241 miles of U.S. shoreline on these inland seas, this year's scanning of Lake Michigan's Wisconsin shore could turn out to be merely a series of test runs for a far grander undertaking. □

THE HUNDRED DAYS OF GATE



The largest international force ever assembled for peaceful purposes is now in the field, occupying positions spanning a third of the earth's tropics.

Its mission is to throw new light on the intricate workings of the tropical air and sea, an achievement that would benefit all of the world's peoples.

Called GATE—for Global Atmospheric Research Program-Atlantic Tropical Experiment—the project is designed to gather the information needed to understand the behavior of the tropical atmosphere and its effects on global weather.

The tropics are a key, but inadequately understood, element of the restless planetary circulation of the earth's atmosphere and oceans. An understanding of the entire global system is a fundamental prerequisite to reliable weather predictions beyond a few days in the future.

After more than four years of intensive planning, the GATE field investigation began June 15 and will continue through September 23. It covers a 20-million-square-mile area of tropical land and sea extending from the eastern Pacific Ocean—across Latin America, the Atlantic Ocean, and Africa—to the western Indian Ocean. Instruments on 40 ships, more than 60 buoys, 13 aircraft, six types of satellites, and at nearly a thousand land stations are observing and recording weather and ocean phenomena from the top of the atmosphere to about 5000 feet below the sea surface.

GATE is the first major international experiment in the Global Atmospheric Research Program, a World Weather Program component sponsored by the World Meteorological Organization and the International Council of Scientific Unions. In the United States, the National Academy of Sciences-National Research Council's U.S. Committee for the Global Atmospheric Research Program provides scientific advice on this nation's GARP programs, and on the GATE project through its GATE Advisory Panel.

The 101-day GATE field study directly involves some 4000 scientists, ship and aircraft crew members, and technicians, from 72 nations. An international control center, established at Dakar through the cooperation of the Government of Senegal, is directing the field operations.

Scientific director for the experiment is Dr. Joachim P. Kuettner, formerly of the National Oceanic and Atmospheric Administration and now Director of the GATE International Scientific and Management Group. Dr. Yuri Tarbeev of the Soviet Union, Deputy Director of the ISMG, is serving as Deputy Director for Operations.

NOAA is coordinating and directing U.S. participation in the project through its U.S. GATE Project Office, headed by Dr. Douglas H. Sargeant. The U.S. Field Office at Dakar is directed by William S. Barney, also of NOAA. Federal agencies contributing to GATE include the Departments of Commerce, Defense, State, Transportation, National Aeronautics and Space Administration, and the National Science Foundation.

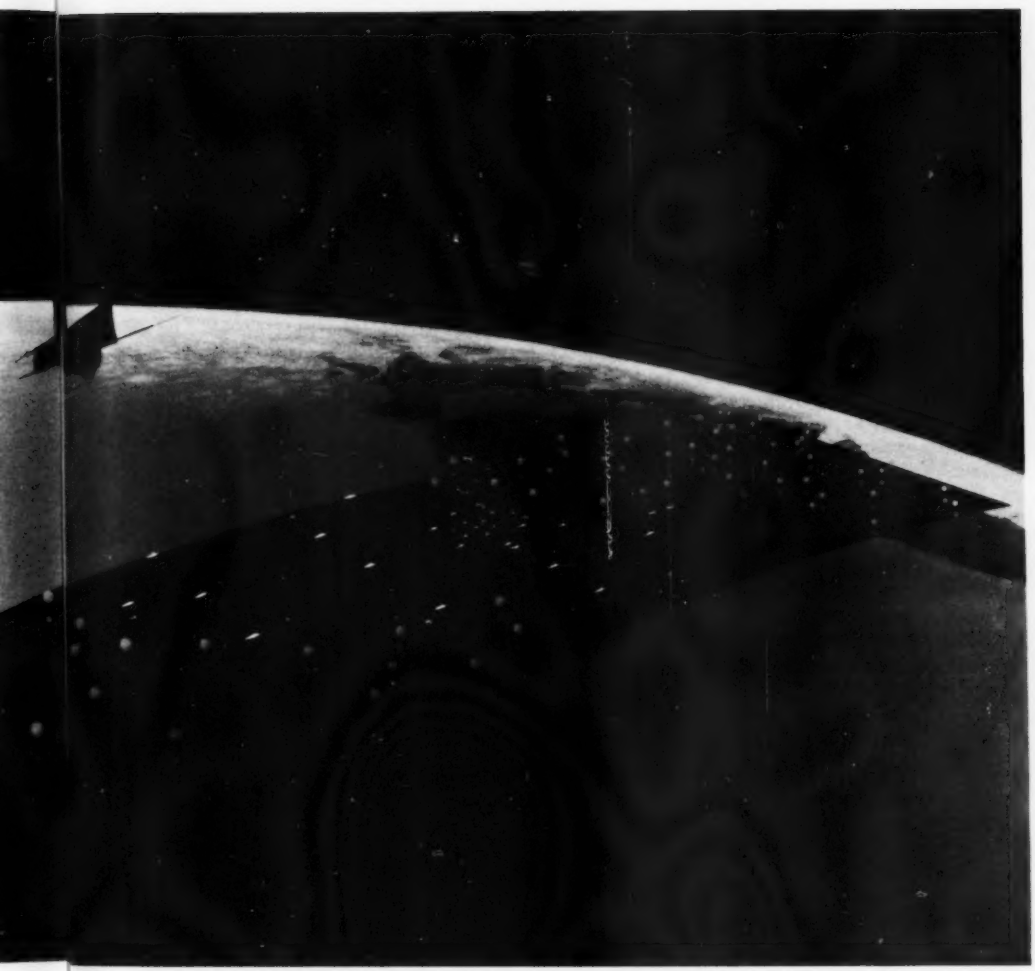
The primary purpose of the Atlantic Tropical Experiment is to collect the massive quantities of simultaneous observations required to enable scientists to understand tropical weather phenomena, describe them in mathematical terms, and develop improved models for computer weather forecasting.

The tropics receive half of the sunshine that strikes the earth and fuels the atmosphere's circulation. Much of this solar heat is first stored in the tropical oceans and then is transferred from sea to air, carried upward in tropical cloud systems, and transported from the tropics by high-level winds. Although these processes ultimately affect atmospheric circulation and weather all over the earth, they are inadequately understood.

Meteorologists have achieved sufficient understanding of the atmosphere, based largely on observations in middle latitudes, to develop mathematical models or sets of equations expressing the physical laws governing its behavior. Programmed for computers, these models—together with the latest set of simultaneous weather observations—are used to produce computerized weather forecasts for several days in the future. But in order to develop improved models that predict weather a week or more in advance with reasonable accuracy, greater knowledge of the special characteristics of tropical weather systems and their global effects is needed.

Greater understanding of tropical weather attained as a result of the GATE project can also be applied to improving forecasts for equatorial regions and of hurricanes and other storms; to developing the observing networks required to provide reliable extended forecasts for higher latitudes; and perhaps to examining the possibilities for modifying tropical weather.

Ships, buoys, balloons, satellites, and land stations are examining weather and oceans over one third of the earth's tropics, in the largest international scientific experiment ever conducted.



Especially in the tropics, weather processes covering a broad spectrum of sizes cooperate to produce effects of global importance. Thus, the Atlantic Tropical Experiment requires an observing system capable of studying the full range of phenomena from small groups of cumulus clouds to huge traveling disturbances thousands of miles across.

Large-scale weather systems are being observed by satellites, planes, ships, and a network of land stations reaching from the west coast of Latin America eastward to the east coast of Africa, beween 10 degrees South and 20 degrees North. At the western end, this area extends to 24 degrees North, to allow inclusion of reports from coastal and island stations in the Caribbean and part of the Gulf of Mexico.

Nearly a thousand land stations are reporting on surface weather and rainfall. A smaller network of stations—generally about 300 miles (500 kilometers) apart—takes upper-air soundings of temperature air pressure, humidity, and wind twice each day. The World Weather Watch network of land-based weather observing stations in the area was augmented for GATE by the World Meteorological Organization's Voluntary Assistance Program.

Six kinds of spacecraft—in the United States' Applications Technology Satellite, Synchronous Meteorological Satellite, NOAA, Nimbus, and Defense Meteorological Satellite and the Soviet Union's Meteor series—are scanning the entire experimental area furnishing day-and-night information on cloud systems, their liquid water content, the heights and temperature of cloud tops, the speed and direction of cloud movement, temperature and moisture in the atmosphere, and sea surface temperatures.

Of the 40 participating ships from 10 nations, about half are stationed at points 300 to 600 miles apart across the Atlantic, measuring sea surface temperatures and observing wind speed, barometric pressure, temperature, and humidity at the sea surface and in the upper air.

To study the internal structure of tropical cumulus clouds and cloud clusters, 14 ships are concentrated within an area of about 200,000 square miles (500,000 square kilometers) in the eastern Atlantic, 600 miles (1000 kilometers) from the African coast. The hexagonal area is bounded by six Soviet ships. Within the hexagon is an even denser formation of seven ships from the United States, U.S.S.R., Canada, and the Federal Republic of Germany, stationed about 90 miles (150 kilometers) apart. In the final phase of the experiment, more vessels—from France, the Federal Republic of Germany, the U.S., and U.S.S.R.—will be added to create a still more closely spaced array, 60 miles (100 kilometers) on a side, where small-scale weather and ocean processes will be examined.

Roving and stationary oceanographic vessels are gathering data on the broad ocean current system near the Equator, which has been termed the backbone of the ocean circulation. Ocean studies within the concentrated ship array focus on the processes in the uppermost layer of the ocean affected by local atmospheric conditions.

The GATE ships are deploying more than 60 moored buoys to gather temperature, salinity, and current data in the oceans and weather observations near the sea surface, and to serve as reference points for navigation.

U.S. vessels taking part in the experiment are the NOAA Ships OCEANOGRAPHER and RESEARCHER, the Coast Guard Cutter DALLAS, NASA's VANGUARD, the University of Miami Research Vessels JAMES M. GILLISS and COLUMBUS ISELIN, ATLANTIS II from the Woods Hole Oceanographic Institution, the University of Rhode Island's TRIDENT, and the Research Vessel GYRE from Texas A&M University.

At their stations in the eastern Atlantic, the NOAA Ships OCEANOGRAPHER and RESEARCHER and the USCGC DALLAS are flying tethered balloons instrumented for measuring temperature, humidity, pressure altitude, and wind speed and direction in the atmosphere at five levels up to about 5000 feet (1500 meters).

The OCEANOGRAPHER, RESEARCHER, DALLAS, and GILLISS have mounted booms extending forward from their bows laden with instruments sensing near-surface radiation, humidity, and temperature, surface wind speed and direction, atmospheric pressure, and rainfall. The systems were

developed for GATE by ERL's Atlantic Oceanographic and Meteorological Laboratories.

These four vessels also have specially designed systems for recording, processing, printing and plotting data gathered by shipboard instruments. The National Ocean Survey's National Data Buoy Office acquired, tested, installed, and is providing field support for the systems.

C-band radars on the OCEANOGRAPHER, RESEARCHER, and GILLISS detect rainfall as far as 200 miles away.

Aboard the OCEANOGRAPHER, an acoustic echo sounder, developed by ERL's Wave Propagation Laboratory determines wind velocity in the subcloud layer. Short bursts of acoustic energy are emitted in three directions from an acoustic-horn antenna array, and the doppler frequency shift of returning echoes is analyzed to find wind velocity as a function of height. Although the Laboratory has use dacoustic echo sounders extensively on land, GATE provides the first U.S. test of the new technique in a marine environment.

A variety of specialized shipboard equipment supports oceanographic studies. The OCEANOGRAPHER, RESEARCHER, GILLISS, DALLAS, TRIDENT, ATLANTIS II, GYRE, and COLUMBUS ISELIN obtain profiles of the ocean's salinity and temperature to depths of nearly 5000 feet at frequent intervals throughout each day. These measurements are augmented by expendable bathythermographs which provide temperature-versus-depth profiles of the ocean.

To obtain measurements of sea surface waves, the OCEANOGRAPHER, RESEARCHER, GILLISS, and GYRE deploy small buoys which remain tethered to the ships. These buoys, provided by a cooperative agreement with the United Kingdom and the Federal Republic of Germany, record wave characteristics as they change in response to fluctuations in the surface winds.

Observations of ocean currents are particularly important to the oceanographic studies. The COLUMBUS ISELIN, and several ships from other nations, are operating current profilers especially fabricated at the University of Miami to observe current variation with depth. The instruments are lowered over the sides of the ships and measure current velocity, salinity, and temperature as they descend.

Similar in principle is an instrument to be deployed by the COLUMBUS ISELIN on thee buoys during the last phase of GATE. Called the cyclesonde, this device uses compressed air to cycle repeatedly up and down the mooring line of the buoy, recording current velocity, salinity, and temperature as it travels.

Among other specialized buoys for GATE oceanographic investigations are two built by NOAA's Pacific Marine Environmental Laboratory, to be deployed from the United Kingdom's ship DISCOVERY. These have current meters and temperature sensors placed at fixed levels along their mooring lines. The surface floats are heavily instrumented for weather measurements.

Thirteen instrumented aircraft from five nations are gathering atmospheric and ocean measurements, principally over the concentrated array. They include a KC–135A from the Federal Aviation Administration, NASA's Convair 990, three planes—an Electra, Sabreliner, and Queen Air—from the National Center for Atmospheric Research, NOAA's DC–6 and WC–130, and an RP–3A Orion provided by the Naval Oceanographic Office.

GATE flights probe the cores of cloud clusters, traverse cloud lines, and investigate the Intertropical Convergence Zone, the atmosphere's lowest layer, ocean waves and surface temperatures, radiation, tropical disturbances and dust layers moving off the African continent, day-night weather changes in the coastal area, and other atmospheric phenomena.

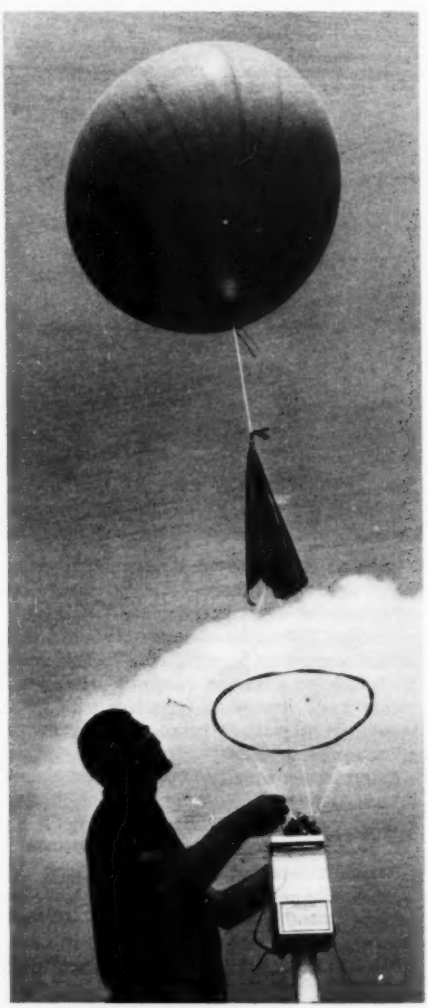
Observing equipment aboard the aircraft varies, but the combined GATE air fleet is capable of making intensive measurements of air temperature, humidity, dewpoint, and pressure; liquid water, nuclei, droplets, ice crystals, and icing rate in clouds; sea surface temperature; wave heights; radiant energy; and atmospheric turbulence. Some are equipped to collect aerosol samples, photograph cloud systems; record weather radar images; and release sounding instruments that return information on temperature, pressure, humidity, and wind velocity between the aircraft and the sea surface.

To permit investigation of a variety of meteorological conditions, use of aircraft during GATE is flexible. Actual flight plans and specific tracks are determined during the 14-hour periods before missions begin.

On most missions, several aircraft begin the first leg stacked vertically at altitudes ranging from 300 to 30,000 or more feet. The three basic flight patterns are: a butterfly pattern for investigating cloud cluster cores; a square or box pattern around cloud clusters or across linear cloud structures; and a repeated traverse pattern through linear cloud formations. These patterns may be repeated several times on a single mission, with the pattern starting from a different point each time in order to follow moving cloud systems. For studies of cloud cluster life cycles, sequential missions are used, one group of aircraft continuing the investigation as another completes its mission and returns to Dakar. Other missions compare aircraft radiation measurements with similar observations by shipboard or balloon-borne instruments.

Within the Dakar Flight Information Region, air traffic control services for GATE are provided by the Government of Senegal, and a GATE-dedicated control position has been established at the Dakar Air Route Traffic Control Center.

The GATE Operations Control Center at Dakar's Yoff Airport, is manned by an internationally integrated staff of scientists



Twice daily, upper-air soundings are being made at land stations in the experimental area.

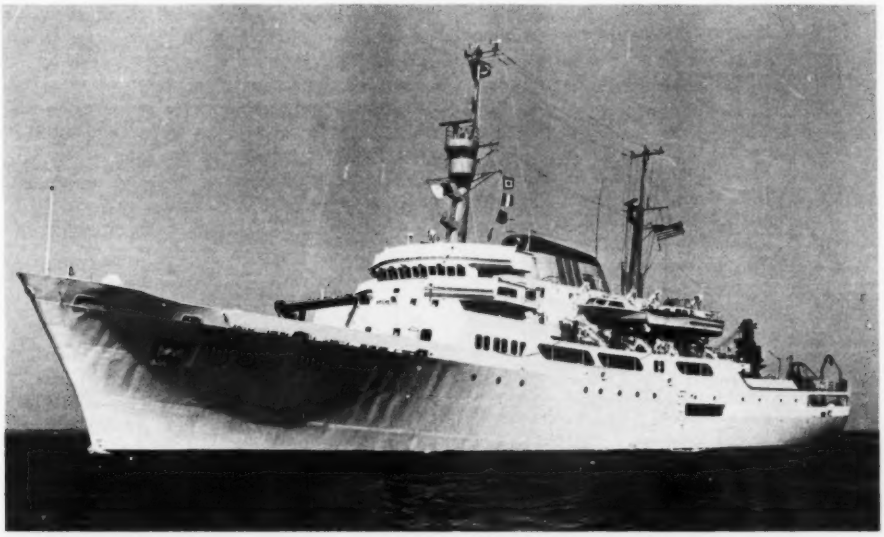
and operational personnel.

For the experiment, the Center provides scientific direction and operational control—communicating with ships and aircraft, controlling mission schedules, planning aircraft operations, monitoring platform status, preparing special forecasts, collecting and relaying data from ships and aircraft, interpreting satellite images, radar, and aircraft data, performing quality control, conducting preliminary scientific analyses, and providing support services for experimental operations in the eastern Atlantic.

A Regional Meteorological Center and Regional Telecommunications Hub, previously established at Dakar as part of the World Weather Watch, make regional and global weather analyses and forecasts available to the Operations Control Center. In addition to collecting some data gathered by participating ships, aircraft, and buoys, the Center receives NOAA satellite data by direct readout, and synchronous satellite images through special links with the NOAA-National Environmental Satellite Service near Washington, D.C. A NOAA Satellite Field Services Station is operating at Dakar for the duration of the experiment to process and analyze data. Weather analyses, satellite images, and data from the observing platforms are used in directing the experiment and checking the performance of the observing systems.

By agreement with the World Meteorological Organization, the Government of Senegal authorized the use of the Regional Meteorological Center and the Regional Telecommunications Hub at Dakar, as well as airport, harbor, and other facilities needed for GATE. Under a NOAA/Senegal agreement, a new building was constructed to house most of the Operations Control Center.

An Electra L-188 from the National Center for Atmospheric Research is one of 13 instrumented aircraft from six nations investigating tropical weather conditions.



The NOAA Ship Oceanographer *is part of a concentrated ship array in the eastern Atlantic, studying the internal structure of tropical cumulus clouds and clusters.*

A U.S. Field Office coordinates and controls all U.S. activities and personnel in the operating area, provides operational support to them, and serves as the primary interface between the international organization and the U.S. participants.

The huge volumes of data acquired during the experiment will be processed in a series of steps, with some available immediately after collection.

Each nation contributing ships, aircraft, buoys, or satellites for GATE will process the observations and intercomparison data collected by instruments on these platforms. Some is being provided directly to the GATE Operations Control Center for operational and scientific use. By March 1976, all national data is scheduled to be sent to the World Data Centers in the United States and Moscow, where it will be available for scientists to study.

Observational data gathered by United States ships will be processed by the Environmental Data Service's Center for Experiment Design and Data Analysis; U.S. aircraft data by the National Center for Atmospheric Research; satellite data by the National Environmental Satellite Service; and oceanographic data by EDS' National Oceanographic Data Center.

The national data sets then will be forwarded to GATE subprogram data centers operated by five nations; the Federal Republic of Germany for the boundary layer; the United States, for convection data; France, oceanography; Union of Soviet Socialist Republics, radiation; and United Kingdom, synoptic data. The five centers will assemble the appropriate national data and prepare products suitable for scientific studies tailored to GATE objectives.

In the United States, EDS' Center for Experiment Design and Data Analysis and the National Center for Atmospheric Research together will comprise the GATE convection subprogram data center, with CEDDA handling ship data and NCAR the aircraft data.

By March 1977, when the basic data sets prepared by the five centers are scheduled to be available in the two World Data Centers, processing of the mass of observations collected in the intensive three-and-a-half-month experiment will be complete. □

"One Foot In Sea and One on Shore"

BY ANN WEEKS

A new kind of seafarer is abroad in the land. He—or she—is young, aware, science-minded, tough, and deeply committed to seeking and finding answers to age-old and contemporary questions about the underwater world. Many of these adventuorous, dedicated people help to accomplish the NOAA mission. This is a story about two of them.

Most aquanauts agree that by far the most tiresome part of any diving mission is the long decompression time, which is usually spent in cramped and uncomfortable circumstances following prolonged periods in water deeper than about 30 feet.

Marine biologist Dr. Morgan Wells was coping with this decompression boredom one day last year while inside a 20- by 8-foot decompression chamber permanently set up below decks, situated level with the water line of a barge anchored off the shore of Puerto Rico. Glancing through the porthole at the by-then monotonous scene of indigo sea meeting Dutch-blue sky, Wells was astonished to see two heads bobbing in the ocean nearby, arms waving in his direction. A closer look revealed that the golden head belonged to his oceanographer wife Anna, the smaller dark head to their seven-year-old daughter Karla. Anxious to see Morgan after his two weeks on the ocean bottom, they had swum out to the barge which was anchored about half a mile offshore to be with him. In a situation that passes as not particularly noteworthy to them, the various members of the Wells family—though uncomfortable, tired, and in slightly precarious circumstances—were happily re-united in the kind of soggy togetherness to which they have become accustomed.

These are the "underwater people"—the aquanauts—of today's scientific world, the marine counterparts of astronauts or "space people." And they are NOAA people. Young, enthusiastic, adventuresome, unconventional, and intensely ocean oriented, couples like Morgan and Anna Wells reflect accurately in flesh-and-blood the spirit of the Federal agency that makes use of their distinctive talents.

Thirty-three year old Morgan Wells has worked for NOAA since 1971, as a member of the MUS&T (Manned Undersea Science and Technology) program, which he joined following the completion of his and Anna's participation in the NOAA undersea project called FLARE (for Florida Aquanaut Research Expedition). Previously he was a research marine physiologist and an assistant professor at the University of North Carolina's School of Medicine. His wife, now 28, at one time served with the Navy as an oceanographer, and later taught high-school in oceanography in Wilmington, North Carolina. When the couple met, she was a graduate student in physical oceanography at Johns Hopkins University.

Dr. Wells, an expert on blood functions under pressure, is perhaps the country's most experienced diver-scientist on coral reefs—he took part in SEALAB II, an early underwater habitat experiment undertaken by the U.S. Navy in 1965; he has participated in expeditions off Australia's Great Barrier Reef, off Polynesia, Micronesia, and Eniwetock Atoll; and he has dived and carried out coral reef studies repeatedly off both coasts of the United States and in the Caribbean. "The world's most saturated aquanaut," his friends call him, pointing out that he has lived in more undersea laboratories on the ocean floor than any other living diver.

During the FLARE Project, the Wellses set a minor but interesting record as the first American husband-wife scientific team to live and work together for an extended period on the seafloor in U.S. waters, but that event went practically unnoticed among other watery anniversaries in the lives of the pair. Though their first meeting was on dry land, at a picnic, their life together really began aboard a boat Dr. Wells called home until a few years ago. They recall that event and others:

"I lived on a boat I kept in the bay near Wilmington. When Anna came down from Washington, D.C., on her first visit, I asked her out for a boat ride. She accepted and that was *it* for us. We fell in love, Anna left college, got a job in Wilmington, and we never parted after that first boat ride. We lived there for the first two years of our marriage," Morgan says.

"We got engaged during Tektite II," Anna says, explaining that the Tektite project was a major U.S. Government and industry experiment with a fixed undersea habitat, off the Virgin Islands in 1970. "I was a working technician with the expedition, and I provided surface assistance to the divers in the habitat anchored on the seafloor. Morgan was part of a team of scientists in the habitat."

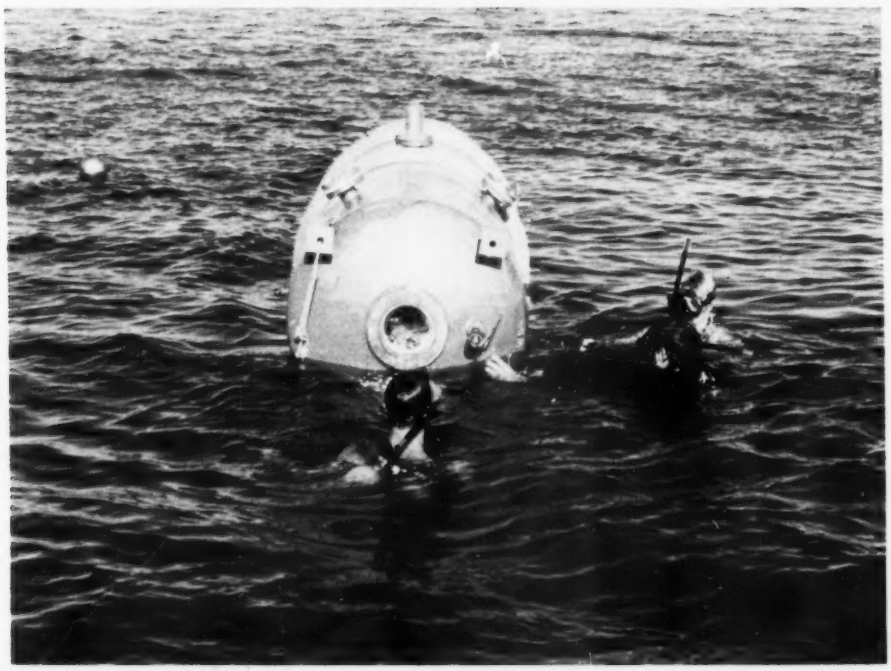
(Morgan interrupted to say that Anna, an accomplished violinist, frequently entertained the submerged investigators with violin music played over the intercom.)

She continues: "A hurricane came along, the divers had to be brought to the surface in a hurry, and decompressed. In the period between Morgan's decompression and resumption of his stay in the Tektite habitat, we decided to get married as soon as we returned to the States."

Daughter Karla may hold an unofficial world's record as the youngest diver ever to enter a bona fide underwater chamber. As a four-year-old snorkeler, she swam down about 12 feet to the "undersea instrument chamber" (invented and built by Morgan to house delicate underwater instruments in a dry enclosure) to enter and inspect the interior of the 16-foot tall facility.

Now 8, she seems to be addicted to the underwater life too. She says that she likes it "better than kite-flying," her present preoccupation. Her real ambition, though, she claims, is "to teach kindergarten in the morning and be a nurse in the afternoon." The family, including a new baby girl (six weeks old at time of writing), will travel to the Great Lakes this summer to spend a month on a study-vacation. They will carry a large amount of oceanographic equipment in their pick-up truck (the Wellses' standard and only mode of transportation) to be used in an examination of the community metabolism of a portion of one of the Great Lakes. Dr. Wells is excited about the experiment, for he has never before used his complicated, custom-made

**Shakespeare—Much Ado About Nothing.*



Aquanaut family Morgan, Anna, and Karla Wells (l. to r., above) where they find much of their personal and professional satisfaction—out on the water. Karla, 8, is an accomplished swimmer. Below, the Wellses with an underwater instrumented chamber designed and built by Morgan Wells for housing delicate scientific instruments.

equipment to assess conditions at the bottom of a large body of fresh water.

The investigatory system generally used by the couple, who work in scientific partnership, seeks to analyze in quantitative detail the makeup of a seafloor community. Often the many separate measuring devices are installed at two separate locations—one adjudged relatively healthy, in good natural balance, and uncontaminated to any great degree by foreign influences; the other a site that appears to be abnormal in some way or likely to become endangered by unnatural factors. The contrasting environments form a basis for comparison.

The Wellses' ecology-measuring apparatus, consisting in part of plastic domes 8 inches to 5 feet in diameter, set in place on the bottom and sealed, effectively measure the various components that bear on the natural production (or lack of same) in the test region. Oxygen, light, and temperature conditions within the domes are recorded on complex instruments within and outside the domes, and readings allow the scientists to calculate photosynthesis and respiration rates, called "community metabolism." Much of the special equipment used in the work is either designed or built by Dr. Wells in the basement of his home because, as he points out, it is not available otherwise.

"Although tremendous advances have been made in recent years in our field, much of our work is still so experimental that we must have or develop an aptitude for do-it-yourself projects," Dr. Wells says. "I've had to learn quite a bit about electronics and other technology, and I continue to do a lot of mechanical work."

His basement workroom reflects that philosophy—it contains a conglomeration of all kinds of gear and miscellaneous objects, including transducers, recorders and control circuits for temperature, batteries, SCUBA gear, a tiny lathe, a hugh clear plastic dome (5 feet high, 35 feet in circumference) and a series of smaller ones, as well as heaps of all kinds of tools. All this resides cheek by jowl with such life support articles as baby cribs, odd lots of furniture, empty wine bottles, a battered playpen, several bicycles, a case of home-canned tomatoes, a pair of polished longhorns, and other evidence of a spirited existence.

Much of the underwater work Dr. Wells has been involved in for MUS&T is in connection with two intriguing ocean-floor laboratories that have seen many months of service in some of the world's most spectacularly beautiful underwater country. The first—and oldest in terms of NOAA service—is HYDROLAB emplaced in 50 feet of water near Grand Bahama Island since 1971. The 16-foot long, 8-foot diameter habitat is submerged on a sandy bottom in the midst of a luxuriant coral reef near the steep drop-off to the deep waters of an oceanic phenomenon called the Tongue of the Ocean. The drop-off is a sheer wall extending down more than 6,000 feet (2,000 meters) to the abyssal floor of the ocean. The site is of compelling interest to divers and marine scientists, and numerous studies of coral reef chemistry and biology have been carried out from Hydrolab by many U.S. and foreign scientists, under the aegis of NOAA's MUS&T program. Dr. Wells frequently is on hand at Hydrolab to assist and advise visiting investigators and to conduct his own biological and diver experiments for NOAA.

A 1973 Hydrolab-based experiment carried out by Dr. Wells in conjunction with Environmental Protection Agency scientists did absolutely nothing to win friends and influence people. Working with borrowed personnel and a work vessel from another NOAA echelon headquartered in Miami, he and the others transported 15 barrels of treated (but still fragrant) sewage from Miami to the Freeport, Grand Bahama location. There the sewage was unloaded and emplaced in the vicinity of Hydrolab. The team set out instrumentation to try to determine the "exchange components," or what amounts of sewage leaked or were transported through the water, and what elements remained on the bottom. The questions to be answered were, in brief, "How does sewage react in a normal oceanic environment?" and "What is a 'safe' amount of sewage in the ocean? And how much of what kind of pollution can be dumped before natural absorption ceases and true pollution begins?" The answers will not be available until the data have been analyzed by EPA scientists at Corvallis, Oregon.

The second most used underwater habitat for MUS&T environmental studies, generally referred to as PRINUL (which stands for Puerto Rico International Underwater Laboratory), is actually named "La Chalupa," Spanish for little canoe or sloop. Hardly a "little" anything at 300,000 pounds, the PRINUL habitat is a portable undersea laboratory that can be used at many locations (to 100 feet deep) to serve as a base for many kinds of scientific studies. So far PRINUL expiditions have been off the coast of Puerto Rico. Either concluded or on the agenda for La Chalupa are projects dealing with the collection of an inventory of food habits of marine life on a coral reef, the testing of fishtrap designs, the testing of sewer outfall criteria design, artificial reef structures, and a continuing series devoted to study of saturation diving techniques that have application to marine science.

Dr. Wells is continually involved in a diverse list of scientific chores ,as a participant (often with unofficial assistance from his wife) and as an advisor to fellow scientists. He explains that both underwater habitats have been leased by NOAA's MUS&T program for scientific and engineering studies. Proposals for use of the habitats for scientific experiments are received at MUS&T headquarters from scientific institutions and individuals all over the country and are evaluated by program personnel—Dr. Wells or colleague Dr. James Miller—or experts outside MUS&T, to ascertain whether they qualify. All projects must meet one of NOAA's important goals—to protect and make maximum use of ocean resources. If the decision is favorable, MUS&T pays the expenses (except for salary and personal costs) to the individuals involved. Expenses run about $5,000 per man per mission for PRINUL, and $2,500 per man per mission on Hydrolab. More than 24 missions have taken place on Hydrolab, 13 at PRINUL, involving an average of three men per mission.

Dr. Wells and his co-workers believe that underwater investigations must stay ahead of, or at the very least keep pace with, other sub-surface exploratory developments such as those in which new sources of energy or minerals are sought, in a constant effort to monitor all effects and help minimize deterioration of the marine environment.

"We have to equal or better the fantastic progress made in less than a decade in the ability of a scientist to work in the marine environment," he says. "Almost unnoticed, diving capabilities have increased by several orders of magnitude in a very short time. During the SEALAB II experiments in 1965, for example, 70 minutes under water with SCUBA gear was considered an achievement. Now seven, eight, or nine hours of work time a day on the seafloor is relatively common, in other words, about the same amount of time a terrestrial naturalist spends on a day's field trip in a forest.

At home in their underwater realm. Morgan Wells works with coral reef respiration processes from TEKITE II habitat (1.); Anna Wells on ladder of EDALHAB during NOAA's FLARE project (top); Morgan using plexiglas cylinder in measurements of metabolic responses of reef organisms to light.

Surrounded by oceanic gear, the family gets ready to travel. Karla sits on diving tanks in the family truck, with plastic dome framing her. At right, Dr. Morgan Wells working in his basement laboratory, where he hand-tools much of the equipment he uses in his underwater biological investigations.

"A working diver may now routinely report back to a habitat to replenish his supply of oxygen instead of—as in the past—having to return to a vessel at the surface. And if yesterday's diver was working at depths, his choices were to return to the surface within just a few hours or be prepared for a 24-hour decompression period. And almost all of today's diving equipment is considerably more reliable and safer than it was just a few years ago."

Dr. Wells and other divers credit the development of the rebreather system for substantially improving diver efficiency. Conventional SCUBA systems rely on about an hour's worth of air carried in tanks, and divers simply inhale the approximately one cubic foot of air used per minute for human breathing, and exhale into the water. Rebreather systems, which are becoming available from military and commercial sources, in effect recycle the oxygen breathed by divers through breathing systems, thus wasting none of the life-giving gas. The systems do not release the used air, but add oxygen to the recirculated (exhaled) gas, so nothing is wasted. Rebreathing permits a diver to carry as much as eight to ten hours worth of oxygen in a single tank, and makes it possible for him to work uninterruptedly at the bottom for that amount of time, at his own pace, almost independent of active assistance. The system also alleviates the undesirable noise and water disturbances caused by air bubbles, which sometimes interfere with the study of marine life.

The rebreather method of diving, which has been used by the Wellses, represents the kind of quantum jump in equipment development that can be realized only through a concerted, organized approach to a problem—the kind of approach MUS&T favors. The program's people believe that the MUS&T effort has paid off in a great many ways during its short existence. Developments within the American sport-diving community were rapid and interesting during the 1960's—diver training and certification organizations proliferated, concepts represented by such experiments as TEKTITE were tested, and various methods of operation and adaptation of equipment were developed that represented significant advances in the state of the art. But much of the development of diving for scientific purposes was on an individual or specialized basis. With the advent of MUS&T, a focal point was established for an expanded usage of diving apparatus and techniques for the study of marine science. The program provided an unprecedented opportunity for scientists and divers to become cognizant of a wide range of efforts and progress in their field. It established quantitative scientific and technical criteria for undersea facilities and platforms through use of available technology, habitats, and submersibles. In addition to offering experimentors concrete assistance in the form of financial aid and access to sophisticated submersibles and equipment, MUS&T has developed instructional material, tables of data needed by divers in a variety of situations, an information service concerning new techniques and safety measures, and a force of MUS&T experts capable of assessing and field-testing proposed diver technology. Its influence as a supporter of undersea technological and scientific projects has been well received by private investigators, universities, State authorities, and a number of Federal agencies. MUS&T projects have been wide-ranging geographically and by subject matter, extending from the North Atlantic and the Bering Sea to the Caribbean, and from studies of asceptic bone necrosis (the bends) in divers to the ecology of the Pacific walrus.

As a result of the considerable amount of publicity given to the personable and highly photogenic Dr. and Mrs. Wells a number of people, young and old, have contacted them asking for advice on marine science and aquanaut-related subjects. Anna, who takes care of such mail, says that a great many teenagers seem to be attracted to their kind of career, and write asking how to break into it.

"We tell them to major in some kind of natural science and get a degree in any kind of ocean science, that it doesn't really matter whether it's oceanography, biology, or what," she says. "Work summers at a marine laboratory of an oceanarium if possible. Even working in a pet shop that sells tropical fish can be helpful. And be ready for a lot of hard, often unglamorous, but unbelievably rewarding work."

Morgan adds: "We're never happier than when working together in the ocean. Life seems reduced to its purest and most beautiful essentials. It's very quiet underwater, and you have a feeling of the deepest peace with youself and the world. Everyday problems seem almost rediculous. The importance of the telephone, the office, and land ambitions and problems recedes and seems extraneous."

Asked whether they will continue with their professional activities as enthusiastically as ever in view of the recent family expansion, the Wellses say emphatically "yes, and expand them." Anna plans to return to the University of Maryland as a graduate student in ocean engineering as soon as their baby daughter is a bit older; Morgan will, of course, continue with and, he hopes, expand his seafloor investigations into broader fields as interest in the subject expands with the national demand for as yet undiscovered products that may lie beneath the sea. And Karla, their daughter, will continue her studies of underwater techniques at the swimming pool down the road from the Wells home, belonging to MUS&T Director Dr. Donald Beaumariage. He learned the basics of SCUBA diving from Dr. Wells, and later qualified for certification as a diver in formal diving classes. Karla hasn't been in a habitat lately, but Dr. Beaumariage's diving capabilities take him to the ocean floor for inspection visits to HYDROLAB during MUS&T missions. □

Anna Wells and baby daughter Annika (named after Anna Wells' Finnish antecedents), born in late January 1974.

Does an 18th century treasure-laden British frigate lie in the East River off 136th Street, the Bronx?

HMS Hussar

BY J. GORDON VAETH*

If you're interested in searching for lost treasure or salvaging historic shipwrecks, you don't have to go very far to do so.

You can try your luck right in the heart of New York City—at the end of 136th Street, the Bronx.

There the East River is dirty, ugly, and about 60 feet deep. Its bottom of silt, tar, and harbor waste is perhaps 30 feet thick. Under these 90 feet of water and muck may rest the remains of His Majesty's Ship HUSSAR and the answer to a naval mystery more than 190 years old.

HMS HUSSAR was a 28-gun frigate built in 1763. Her keel measured 103 feet, her beam 33. On November 13, 1780—the American Revolution then being on in full force—she arrived in British-held New York, part of a convoy that had set out from Cork, Ireland. Commanded by Captain Charles Morice Pole, she had taken two American prizes and was carrying 53 prisoners who, according to her log, were transferred to a prison ship in Wallabout Bay, later to become the site of the Brooklyn Navy Yard.

Thursday, November 23rd, Pole set sail again, this time for Gardiners Bay at the end of Long Island. There HUSSAR was to rendezvous with other ships of the Royal Navy. Her course would take her up the East River and out into the Sound through the turbulent currents of Hell Gate.

In 1780 Hell Gate was aptly named. Its treacherous waters wouldn't be dredged and the worst of its rocks blasted out until the next century. HUSSAR's pilot, a man named Swan, did his best. Even so, at 3 p.m. the 620-ton vessel ran upon Pot Rock and holed her bottom. Pole headed the ship for the closest land current and wind would permit him to reach. It turned out to be the north shore of the river, an area now known as Port Morris, the Bronx.

Details are confused. One account had it that HUSSAR was beached, tied by heavy lines to nearby trees, and, when she slipped under, pulled the trees up by the roots. Another had her taking eight hours to go down. According to a certain Fletcher Betts, who claimed to have been a petty officer aboard her, HUSSAR was beached in a bay called "The Brothers." She sank about seven in the evening, so he said, causing the deaths of 107 crewmen out of about two hundred.

The battered copper-sheathed hull had scarcely settled to the bottom before the stories began. . .

HUSSAR, it was whispered, had brought specie from England to pay British troops stationed in America. This same Betts claimed to know that £20,000 had been offloaded while the vessel was in New York. Perhaps she still had more on board when she headed seaward to join the Fleet off Long Island. After all, the officers and seamen of His Majesty's Navy had to be paid too! Thanks much to Betts, HUSSAR quickly became synonymous with "treasure ship." (It's interesting to note that an investigation made by a New York newspaperman in 1930 failed to find any listing of Betts in British Navy payroll records of the time.)

Over the years, the rumors persisted and grew. In January 1812, HUSSAR's captain, long since exonerated of the loss of his ship and promoted to Admiral, felt obliged to write: ". . . I am not aware that there was any treasure on board her or anything but stores belonging to her as a 28-gun ship. . . this may perhaps serve to prevent disappointment for future seekers of treasure trove."

Those wanting to believe that gold and silver lay in the water off Port Morris immediately took Pole's denial to be a confirmation. Of course he'd deny it, they reasoned. He didn't want British money falling into American hands.

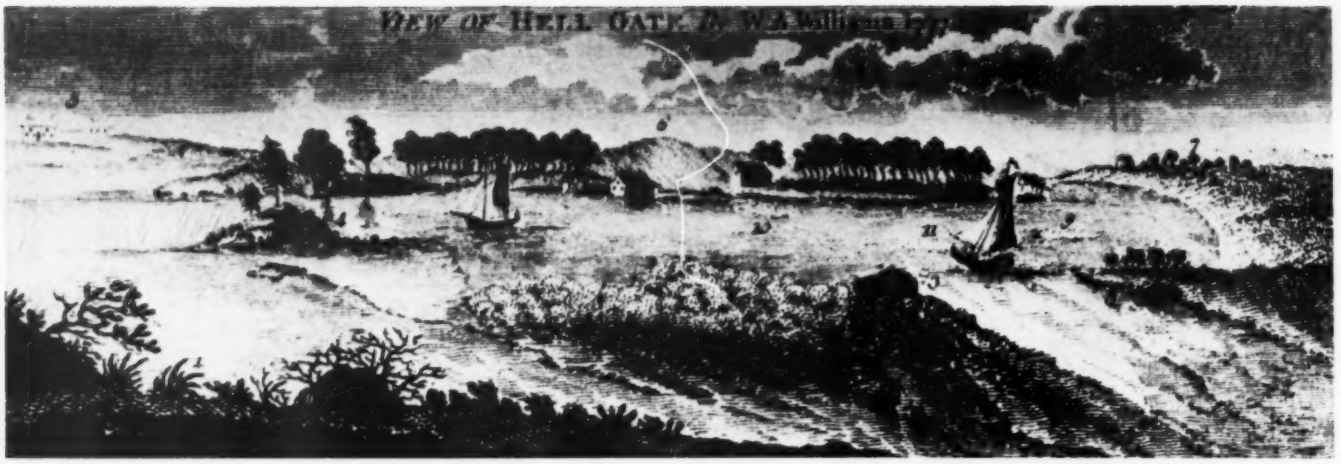
Pole's statement was possibly triggered by a salvage attempt made on HUSSAR the year before. Men working on the wreck from a diving bell were able to recover her rudder. They found the vessel lying on her port side with her keel pointed toward the shore 180 yards or so away. One diver reported running his hand over a cannon and judged, from its smoothness, that it was brass. This expedition apparently succeeded in entering HUSSAR and bringing up butter and one or more bottles of porter—but no treasure.

In 1819, the money-ship theory received a sudden boost when Samuel Bleeker of New York made a deposition. His father had seen fourteen carts, ten of them carrying a chest of silver coins and four a chest of gold coins, escorted under guard to Beekman Wharf where they were put aboard HUSSAR just before she sailed.

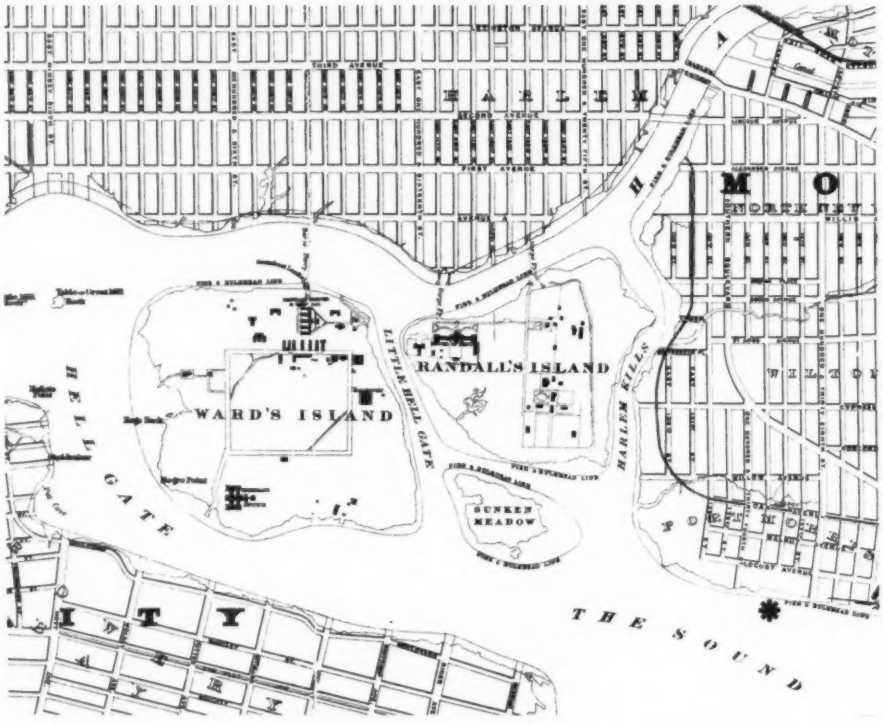
Whether or not a direct result of Bleeker's sworn statement, the next major salvage effort sought to raise the hull. The NEW YORK EVENING POST on August 27, 1824, reported that the work party had lifted 40 feet of the stern: ". . . after placing chains under her and moving her from her bed, she broke in two from the keel up through the quarterdeck. The forepart of the ship slipped from the sling and settled down again on the rocks. The timber of such part of the ship as was embedded in the mud is perfectly sound. The remainder is completely worm-eaten and rotten. A number of cannon and shot were brought up with the hull. . ."

Salvagers expected to find shackled human remains as well as specie in the wreck. According to one widely accepted tale about HUSSAR, she had American prisoners in

J. Gordon Vaeth is Director, Office of System Engineering, National Environmental Satellite Service.



A view of Hell Gate as it looked at the time HMS HUSSAR *met her end in the treacherous waters off the Bronx, from a British chart. The map below will locate the site for prospective treasure hunters.*

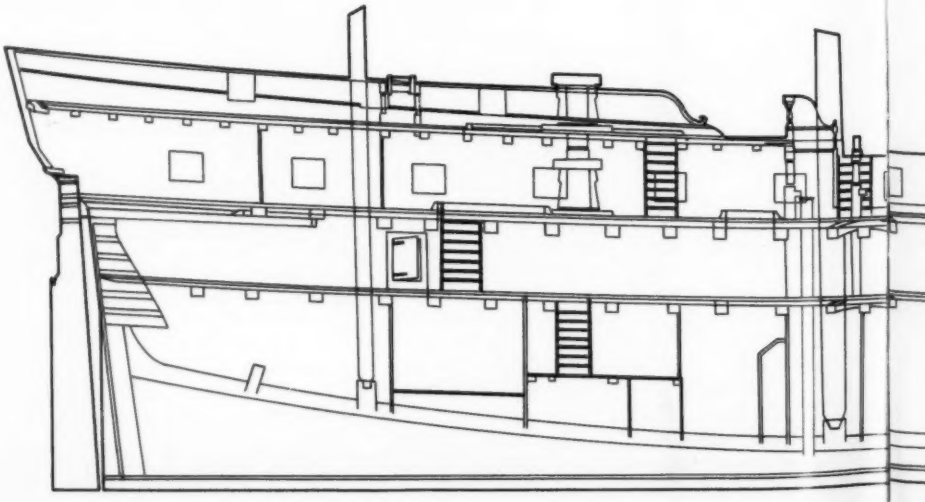


her hold when she sank. Whether these were supposed to be the 53 she had brought into New York or still others was never made clear. In any event, the next retrieval attempt, this one by the Worcester-Hussar Company of Worcester, Massachusetts, allegedly brought up arm and leg bones, purporting to prove that there had been Americans on board in manacles and chains.

The Worcester-Hussar Company was active from about 1840 to 1866. During this period, the closed diving suit, introduced by Augustus Siebe in 1837, came into its own. Divers working inside of suits instead of from bells enjoyed and took advantage of their increased mobility. They delighted, too, in their freedom from concern that the bell might tip in the river current and lose its precious bubble of air. From HUSSAR various small artifacts were reportedly found and recovered. As of 1856, the only money retrieved was 19 gold guineas variously dated 1711 to 1776.

Addison Bishop, builder of harbor derricks, was one of the next to be bitten by the treasure bug. Before diving on the wreck, however, he wanted to see what the British archives had to say about the vessel. He could find nothing in them about any money shipment. Unconvinced there ever was gold or silver on board, he lost interest about 1883. When he heard HUSSAR had taken hours to sink, he further concluded that had there been any treasure it could have been and would have been removed.

George W. Thomas thought otherwise. In 1880, he obtained a contract from the Secretary of the Treasury to raise and secure HUSSAR's treasure. Under its terms, the United States Government was to receive



10 percent of the gross proceeds of any coin or bullion recovered, also all historical relics. Thomas' share was 90 percent of the proceeds. All expenses were to be borne by him.

The enterprise failed. Progress in working the wreck was slow. The investors became impatient. The government annulled the contract in 1884.

Its fingers burned and not yet healed, the Treasury proceeded immediately to enter into a similar arrangement with Messrs. Beane and Hartwell, two of Thomas' investors. They, in turn, affiliated themselves with an organization called the Treasure Trove Association. It ceased operations in 1885.

Next on the scene: Francis M. Epply, His credentials were impressive. Four years working with the U.S. Coast and Geodetic Survey. Experience as a hydrographic surveyor in the demolition of Hallets Point at Hell Gate and in the recovery of wrecks from the harbor at Charleston, South Carolina. Like Addison Bishop, he searched the British records. Like Bishop, he dropped the idea of going after HUSSAR.

A quiet then settled over the mystery of the treasure of HMS HUSSAR. Not until the 1930's would the subject become really hot again. There was a brief flurry of excitement in 1903, however, when an anchor with the letters "H.M.S. HUS__" was reportedly found in the Hell Gate area by members of the Oak Point Yacht Club while dragging the bottom for a missing yacht. Supposedly they gave it to the American Museum of Natural History. In keeping with the character of the HUSSAR story, an inquiry made by the author to the Museum revealed that it has no record of having ever received such an item. As for the Oak Point Yacht Club, no one seems to have heard of it.

In 1933, the submarine pioneer, Simon Lake, took up the challenge. His contract, dated March 3 with the Treasury Department, was like those given a half-century before to Thomas and to Beane and Hartwell. Lake wasn't the only one interested in the wreck at the time. Permits, issued by the Coast Guard's Barge Office to R. T. Powell and the Empire Salvage and Engineering Corporation to work on HUSSAR, had to be cancelled when he received his contract.

For some time after HUSSAR had sunk, there was no question at all about her location. Her masts protruded above the surface of the river, clearly marking the spot. By the time Lake came on the scene, however, her whereabouts were no longer exactly known.

Remembering Fletcher Betts' account that she had gone down in "The Brothers" bay, Simon Lake set about trying to identify the spot: "From an old map (1777)," he wrote in a progress report to the Secretary of the Treasury, "a shallow bay extended inland from Stony Point. The entrance channel was at 136th Street. This bay has been filled in and docks and the 136th Street Municipal Pier have been built over it. The pier head extends 153 feet out into the river. The depth is 72 feet just off the end of the pier. The remains may be under the dock."

That report of June 24, 1937, then adds: "We were not able to get closer than 50 feet to the 136th Street Pier because barges are constantly being loaded with scrap iron for foreign shipment. . . much has fallen overboard and is embedded in silt which, in some cases, is over 25 feet deep."

The results of Lake's efforts were summarized in a letter dated August 6 of that same year addressed to him by the Acting Secretary of the Treasury. "You have drilled over 100 holes through the silt to hard rock between the 134th Street Ferry Slip to within 50 feet of the 136th Street Municipal Pier wihout locating the wreck. . . you have completed the search of the entire river frontier frontage of Stony Point except for 30,000 square feet, part of which is covered by the Municipal Pier and in which you feel the HUSSAR must lie."

Originally Lake's contract was to run two years. He received at least two extensions of it, each time claiming to be on the verge of success. His last request for one was in 1939. The outbreak of World War II ended official support of his work. He abandoned it, his drill never having brought up the hoped-for evidence that the resting place of the frigate had been found.

And there, except for a statement by Bronx Borough President James J. Lyons in 1940 that his office would be glad to share the treasure with anyone able to find and recover it—80 percent for the Borough, 20 percent for the salvager—the search for HUSSAR came to a halt.

Thirty-four years have since passed.

The Municipal Pier that blocked Simon Lake's way is now gone, although the pilings remain.

As the American Revolution Bicentennial approaches, the nation is looking for unusual and challenging ways to celebrate it. Locating HUSSAR and recovering as much of her as possible could be one of those ways. . . imaginative. . . daring. . . and historically significant.

Regardless of the legend of the treasure—and it may be just that, a legend—Simon Lake could very well have been right. HUSSAR may indeed lie at the foot of 136th Street.

Have her timbers been preserved by the mud or are they completely gone?

How many of her cannon—24 nine-pounders and 4 six-pounders—might still be there?

Why, despite so many salvage efforts over the years, are relics from the ship so scarce, in fact virtually non-existent? As far as is known, no maritime museum in the country can produce an artifact from HUSSAR!

What happened after she slipped from the sling in 1824 and reportedly broke in two? Was everything, including her distinctive heavy chalk ballast, carried away by the current?

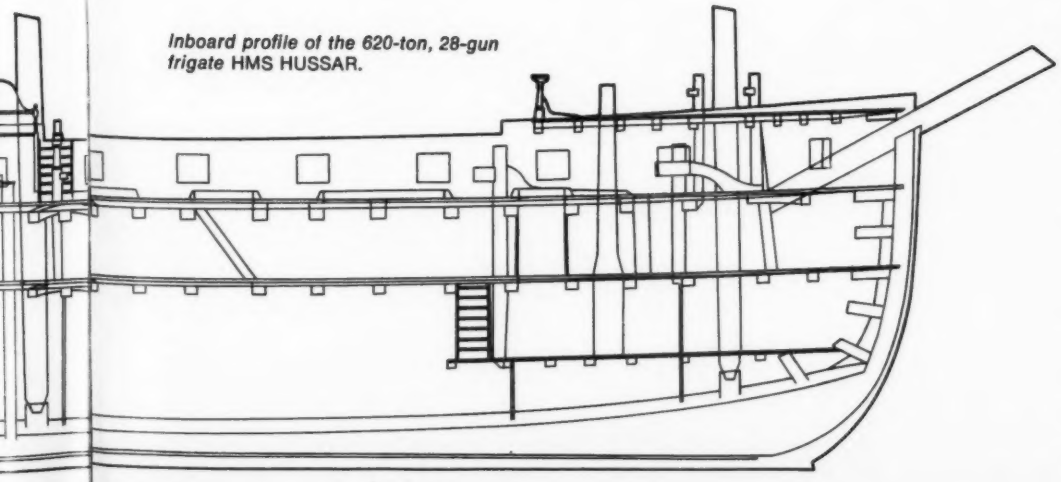
These are some of the tantalizing questions that cry out to be answered.

From what Lake said about scrap littering the bottom, searching for her with metal detectors would be of little use. But how about acoustic techniques that can penetrate and return a profile of the river's subbottom? How about the latest in corers, samplers, and drills? And how about the capabilities of late-model underwater cameras and lights?

The number of Americans who "go down to the sea" for sport, adventure, and recreation totals in the millions. Equally impressive is the number of commercial firms engaged in underwater exploration and salvage. Even so, nobody, amateur or professional, apparenlty has his eye on HUSSAR or plans to resume the two-century-old quest to find and recover her.

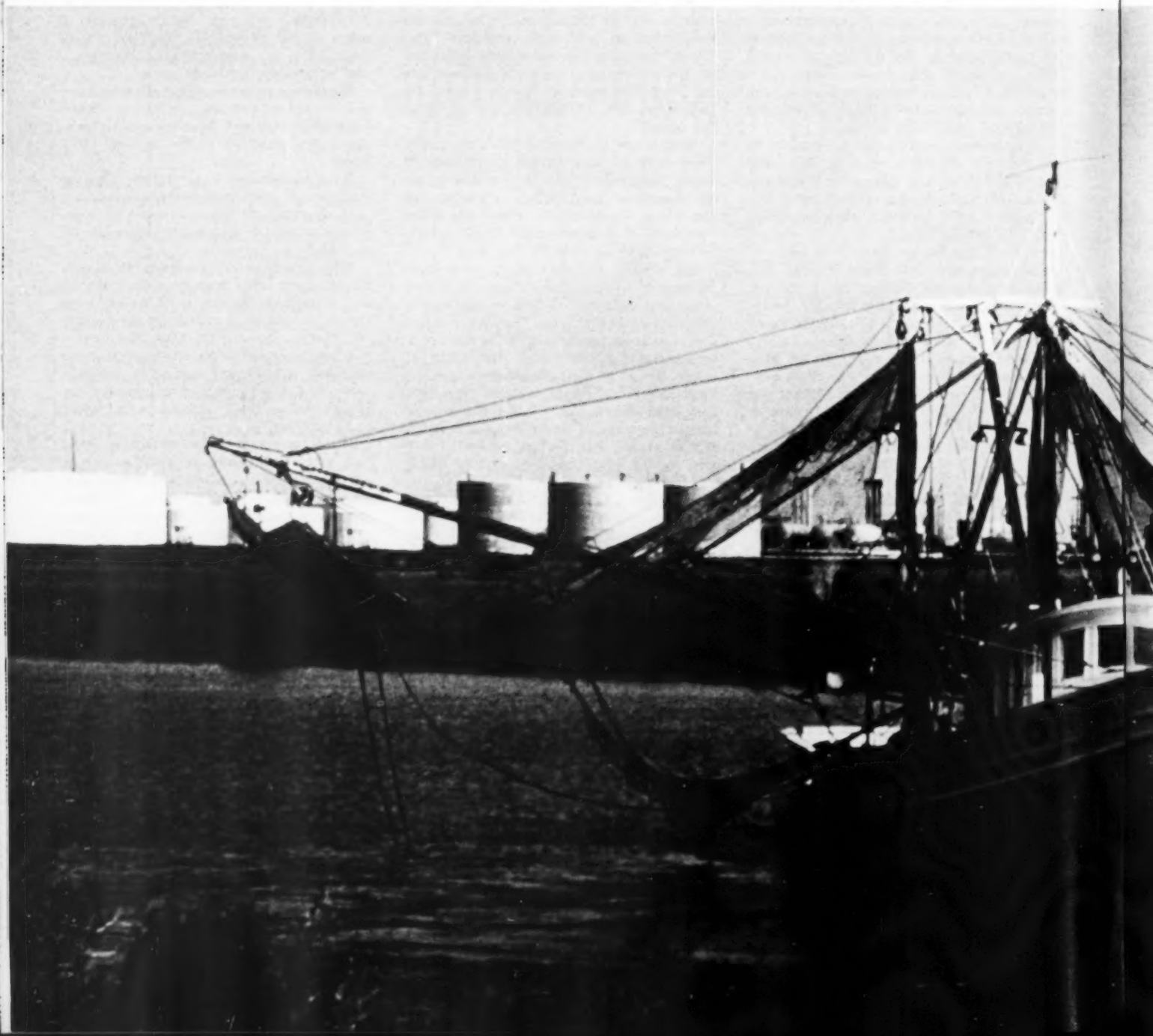
Yet the place to resume looking is clearly known and easily accessible. And never have better tools been available for the job.

Surely someone someday will pick up the challenge again. □



Inboard profile of the 620-ton, 28-gun frigate HMS HUSSAR.

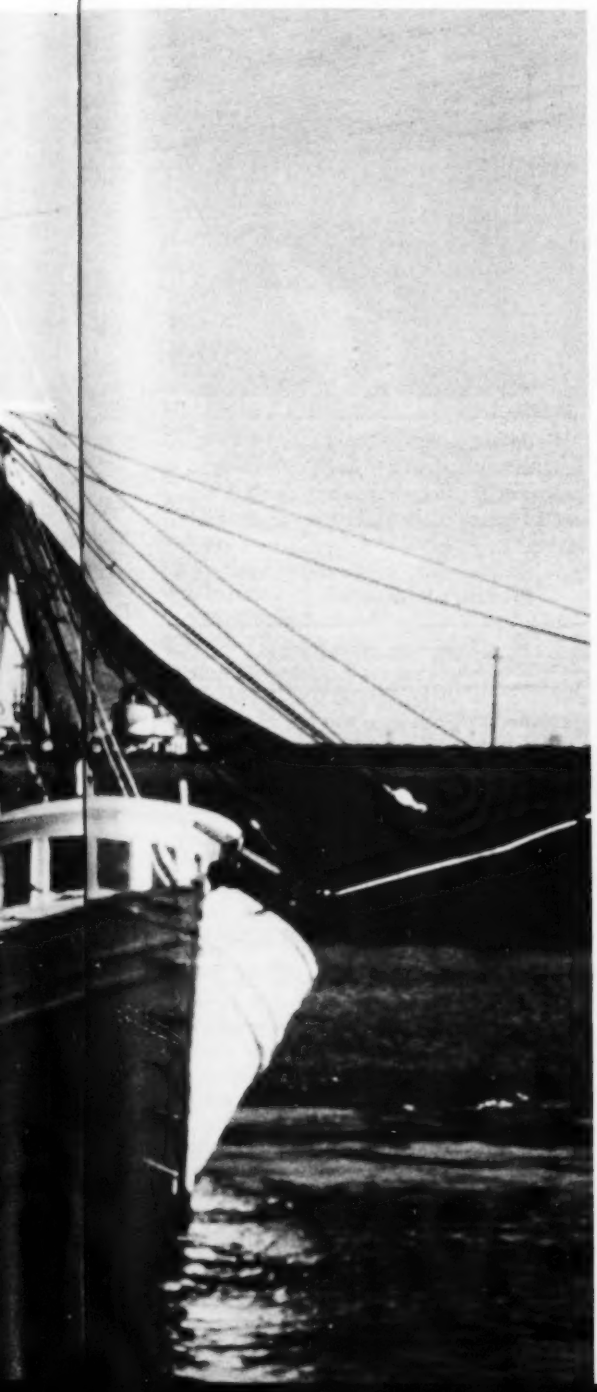
Commercial fishermen in America's coastal waters bring protein to the nation's tables.



A variety of viewpoints and convictions met in Charleston, S.C., when NOAA addressed

The Coastal Imperative

by Roland Paine



The Congress finds that "There is a national interest in the effective management, beneficial use, protection and the development of the coastal zone. . . ."

This phrase in the Coastal Zone Management Act of 1972, the Congress called attention to America's coastal zone as an area where there are not only local, state, and regional interests, but where there is also a national interest, which the Secretary of Commerce must take into account in making a grant to a state to support its coastal zone management program.

But what is the national interest? Early on, the coastal zone staff of NOAA—which carries out for the Department of Commerce the responsibilities provided in the Act—concluded that this phrase was not intended to mean merely a "Federal interest", and still less a "Federal government interest". National interest, they surmised, is a broad term used to embrace in the widest sense tne well-being of the nation as a whole. It is a general guide, a philosophical concept that helps remind the government servant of his wider responsibilities, of the higher goal of public weal toward which all his activities and his policies ought to be aimed.

Within the framework of the Act, it became incumbent upon Robert Knecht and his Office of Coastal Zone Management to seek ways to define the characteristics of the national interest and to try to incorporate it as an active component of coastal zone management decision-making within the coastal zone management programs of the State and the Nation. Hence, "The Coastal Imperative", a national conference on coastal zone management sponsored by NOAA and held in Charleston, S.C. in March of this year. The objective of the Conference, said Administrator Robert M. White, was "to elicit a wide range of views concerning the nature of the 'national interest' in coastal decision-making. . . . As States begin the process of developing coastal management programs, it becomes important that the nature of the national interest in the coastal zone and how best to incorporate this interest into State programs, be generally understood."

The keynote was sounded by Senator Ernest Hollings of South Carolina, who discussed the history of efforts to bring coastal zone problems to the nation's attention. "When I first started working on Coastal Zone legislation," he said, "it was looked upon as a nice thing, not a necessary thing." . . .

"At that time we were looking ahead. Now with the energy crisis, we are looking behind. Already in commission are 30 super-tankers that have no United States ports of call. There already should have been constructed offshore nuclear power plants.

"And with the oil shortage, we have yet to look at our hole card, the outer continental shelf along the Atlantic Coast. Thanks to the energy crisis, the pressure for super offshore drilling, super power plants, super ports—all this creates national needs and conflicts now in the coastal zone. Somewhere along the coast in the Northeast, we are going to have to construct floating nuclear power plants, offshore oil and gas drilling sites and a superport.

"There will be give and take between energy and environment. Neither need suffer. But neither can stand to wait. If coastal states don't move, the federal government will be compelled to move for them. Coastal zone management, therefore, is no longer merely desirable—it is necessary now."

The question of the decision-making process in coastal zone management was dealt with by several speakers, recognizing that it is at this level that national and local interests, as well as the varying interests of commerce, of the environment, of energy development, and others are brought to bear. Several speakers underlined the importance of involving the public, not just through various levels of government, but in their community and volunteer capacities. "The question is how does one establish a process, make a

Huge "supertankers"—can offshore ports be built to accommodate them?

EXXON Photo

plan, determine a set of procedures whereby not only are local considerations taken into account, but also how can the broad economic consequences to the nation be taken into account," said Dr. J. Herbert Hollomon, Director of the Center for Policy Alternatives of the Massachusetts Institute of Technology.

"It is very clear, it seems to me, that we will have to have in the United States, a very substantial number of refineries. It is also very clear, it seems to me, that we will have to have a tremendous effort to increase the coal supply from the western coal fields of the United States. That is necessary in the general national interest because the broad economy of the United States will depend in part upon the presence of refineries and the mining of coal in Wyoming and Montana.

"Local interests on the other hand, balancing their environment degradation or aesthetics of the region, may determine one at a time that refineries of that type are undesirable, too costly for their own set of values. . . .

"If we cannot learn in a complex interacting society to balance local versus social gains or local versus social costs by doing it mostly at the level of the people who are affected, in my view, there is only one alternative and that is that the cost will become so high that central planning and central authoritative determination of the use of national resources will be required—an end which I suspect none of us would like to foresee."

Jack Heinemann, Assistant Advisor on Environmental Quality of the Federal Power Commission, echoed Hollomon's call for clear statements of alternatives, and gave a compelling example from the electric power field. "It would seem to me," he said, "that one approach to incorporating national interest in the type of plans called for in the CZM Act and especially involving energy-related facilities would be to present the public with a set of analysable alternative courses of action that could be carried out to meet the national needs—beginning with methodology similar to that required in Section 102, National Environmental Policy Act.

"If coastal states don't move, the federal government will be compelled to move for them. Coastal zone management is no longer merely desirable—it is necessary now."

Senator Ernest F. Hollings

"We do not intend to build a massive federal bureaucracy to handle this new program. Rather we see the principal action taking place at the state and local levels."

Secretary of Commerce Frederick P. Dent

"Additional steps should be provided for showing citizen participation in an orderly, effective, and simplified manner.

"It may be true that no electric power plant can be indispensable by itself. In other words, it is always possible to argue that this particular plant should not be built here. However, additional single marginal plants . . . are clearly not marginal as a set."

Fundamental to the operation of the Coastal Zone Management Act of 1972 is the principle that primary responsibility for the coastal zone lies with the states, with strong Federal and local input. In the evolution of policy and procedures to reflect the national interest, the varying needs and capabilities of these jurisdictions has to come into play, just as the varying needs and capabilities of the private sector must interact with those of the government sector. Secretary of Commerce Frederick B. Dent, in a major address at the Charleston conference, pointed out that the Act is an example of the Administration's effort to increase the responsiveness of government to the people, noting that "the guiding principle behind new federalism is that the level of government closest to the people can respond more effectively to the people's needs and wishes."

"Bear in mind," he went on to say, "that participation in the federal Coastal Zone Management Program is not mandatory. There are no sanctions against the state that chooses not to participate. Hopefully, however, most coastal states will find it to their advantage to be a part of the program. . . ."

He commented on the way that the Department of Commerce through NOAA, will administer this program, as well as others in the Department that are related to the coastal zone. "Our principal aim," he said, "will be to give maximum assistance to the states and through states, to local governments in financial and technical terms. We will be sensitive to the needs of the private sector to be involved in both the federal and state process at key points. We will also work hard to ensure

Photo: EPA-Documerica, Gary E. Miller

One use of the oceans: a receptacle for wastes that the land cannot absorb.

that the public has a full and effective opportunity to participate in these processes as well.

"We do not intend to build a massive federal bureaucracy to handle this new program. Rather we see the principal action taking place at the state and local levels."

Kicking off the session on "Coastal Decision-Making as Viewed from Washington" was Nathaniel Reed, Assistant Secretary of the Interior for Fish and Wildlife and Parks. In a candid and provocative talk, Reed bore down hard on precise difficulties that arise between federal and state jurisdictions in coastal management, and how he believed the national interest had to be protected. He said:

"A bluntly stated fact, not willingly accepted by all concerned with the Coastal Zone, is that in navigable waters of the United States, the federal role is paramount. Decisions of the Supreme Court have established that such waters are public property of the nation.

"As a result, I believe that fish- and wildlife-oriented agencies of the federal government must continue to address and discharge the mandated national interest or responsibilities in the coastal zone as they do elsewhere.

"Such responsibilities are clearly spelled out. Every state director in this room knows that I believe that Uncle Sam cannot go alone without the state's enthusiastic support and protection of the coastal zone or any other critical habitat. It is hopeless.

"I would be less than candid if I did not report that I honestly believe that far too many dredge and fill permits may get through the state review process. I can assure the states that NOAA and the Fish and Wildlife review officers would like nothing more than to see the states take a leading role in protecting their estuaries. That is the thrust of the Act. That is the thrust of new federalism. . . .

"In turn, and to some extent, the states have largely delegated to local governments, most of their powers with relevance to the management of coastal as well as other lands. . . .

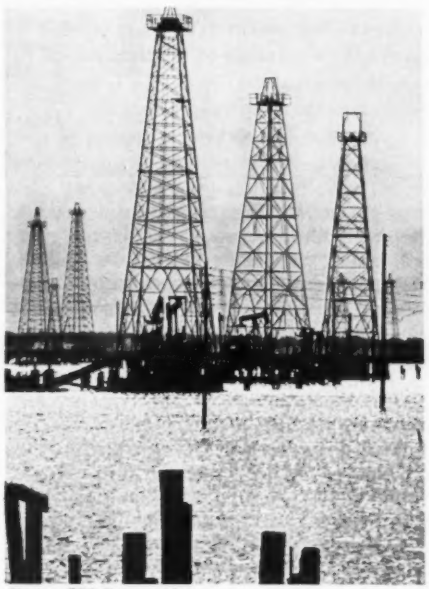


Photo: EPA-Documerica

"The states who simply choose to take advantage of the provisions of the Coastal Zone Management Act can readily comprehend the whole of ecosystems rather than just parts. There is no question that the nation's coastal ecosystems are the areas most seriously threatened by man's activities. Three kinds of threats stand out. One, the chemical destruction such as dredging and filling of productive wetlands and shallow water bottoms; two, deterioration of the quality in the coastal water including waters derived for runoff from the land; and three, reduction in quantity of fresh water inflow to the estuaries. . . .

"Let's face it. The states and the federal government are being overwhelmed with permit requests. If we establish some clear, non-negotiable rules, we can deny a large percentage of permit requests outright as they are either totally inconsistant or outdated with our mission.

"It would also be a good idea if the states would extend the application of such guidelines to critical areas outside of the federal review. Such actions would permit the protection of entire ecosystems, for example, marshes and mangrove forests above the high water mark."

Representing the White House at the session was Richard Fairbanks, Associate Director of the Domestic Council, who also underlined the importance of state decision-making. He pointed out that President Nixon's definition of new federalism is "simply a reexamination of our federal structure to try to make it as responsive as possible" to the particular citizens whom the decisions of government affect. He noted that new Federalism does not believe that there is a vacuum in state and local government decision-making—quite the reverse, it believes that these are the growing and emerging governmental decision-making levels. Through new federalism, he said, "we want to force decisions down to the level closest to the people." As for the federal role, he went on to say:

"I would like to share with you briefly several particular viewpoints on the federal level which we think are appropriate in looking at the way states do their business. The first is we see a clear duty on behalf of the federal government to define and to state the national interest. . . .

"Second, of course, the federal government is the largest land holder in the country. And, as such, we have tremendous impact on what happens in land use and coastal zone at the local and state level just by how we manage on the federal level.

"Third, the federal decisions and federally funded programs have an obvious impact. How much money, how it is targeted, what guidelines are established for mass transportation, highways, or housing, labor, etc., will have a tremendous impact again on the state and local level, dispersion population, the pressures on coastal zoning in particular areas.

"Fourth, we have a need to facilitate the federal review of project proposals. . . .

"That is the idea behind the Coastal Zone Management Act and proposed Land Use Bill—not to get the federal government in there getting its hands dirty

Sen. Ted Stevens of Alaska (c) chats with Mr. Knecht and Dr. White at Charleston.

making decisions, but rather to say that there is a clear federal interest that particular interests are comprehensibly addressed. And, that decisions closest to the people are made at that level, but they are made comprehensibly."

Senator Ted Stevens of Alaska brought another perspective to the conference. Although a political figure at the national level, Senator Stevens represents some very special, very unusual state interests that the "lower 48" don't often think about. "Our difficulty in the past," he said, "has been that all too often national rules and regulations have been made by administrators who believe that the total of the United States is in the temperate zone. We are trying though our state officials to identify Alaska's problems and to convince our federal agencies that, having identified these problems, our Alaskan people know best how to solve them."

Pointing to the "tangled web" of state and federal interests in Alaska, he said that although Alaska is a special case by virtue of its geography, its problems in resolving the state-federal jurisdictional questions are not unique. "The great problem of national standards and the problems created by those who seek to achieve those standards through federal fiat rather than through sensible application of solutions designed to meet the problem in a particular area is, in my opinion, certainly not unique to Alaska," he said. "The Coastal Zone Management Act offers the great hope of stimulating state and local action in the national interest."

Philip Savage, State Planning Director for the State of Maine, underlined the remarks by Sen. Stevens. "Let me make it clear," he said, "that the State of Maine has no intention of abdicating its responsibilities to national interest in the coastal zone. We do not know what national interest is. Study after study point out and reach the same conclusion; the federal programs and policies of the many federal agencies duplicate, conflict and represent a fragmented approach, as seen from another level of government. Every year the national governor's conference requests numbers and the administration takes immediate action to correct this confusion, this duplicated overlapping mass of federal policy requirements and definitions. Every year, the national governor's conference repeats the need for the President and the Congress to set national goals to guide the efforts of state and local officials.

"All too often national rules and regulations have been made by administrators who believe that the total of the United States is in the temperature zone."
Senator Ted Stevens

"We, finally, have no clear national goals. We have no national policies; we have no comprehensive plans. So the states are forced to determine national policy from a great many national laws and from a great number of federal agencies' procedures adopted to implement these laws. . . .

"It is unrealistic to expect any individual state to coordinate to the federal establishment. We can, however, speaking for the states, provide a framework for federal cooperation with the state plans, provided that the federal establishment is really prepared to recognize all the plans. I am very concerned over the way the federal agencies will organize the input into the state coastal zone plans. If it becomes too complicated, too complex, state initiative and authority will quickly be eroded."

"Federal statutes and administrative regulations . . . are so involved and so complex that some means must be found to simplify and integrate them for use of the coastal states."
Philip Savage, State of Maine Planning Director

On the other hand, the programs that Savage saw as chaotic and undirected, Lee Koppelman, Executive Director of the Nassau-Suffolk Regional Planning Board, saw as great opportunities for local government such as that he represented, to achieve cohesion and support in its coastal zone planning efforts. "My colleague, Mr. Savage," said Koppelman, "made an eloquent presentation and said that he knows of no example where federal-state agencies have worked out a harmonious coordination, particularly involving the coastal zone. Our experience on Long Island has been just the contrary, so perhaps it will be the one example that he has been seeking. . . .

"In our experience, we think the federal participation has been notable. For example, HUD's Urban Planning Assistance proposal, the Flooding Assistance program. There are problems, granted, but without the programs we wouldn't be where we are. We wouldn't even commence a coastal management program at this time. NOAA's Sea Grant program and the new marine ecosystems analysis, EPA's efforts to combat air and water pollution, Department of Interior's regulation of development of resources on the outer continental shelf—I don't put any qualitative connotations on this. . . .

"We created a 15 member body, representing every facet of commerce and industry, civic and conservation interest, that had a direct interest or concern for the marine environment. We met every single week and we invited participants from every field of endeavor: judges, marina operators, shellfish people, commercial fishermen, sports people, conservationists. Each week we had a different

Photo: The Port of New York Authority

Seaports—an early use of the coastal zone, of undiminished importance.

Photo: John Roseborough

A quiet stretch of beach for recreation and fishing, necessary for quality of life.

group come down and present briefs and testimony, for more than a year.

"What was fascinating was that by the end of the year, a thread permeated the entire study, that there was absolutely no conceivable way to promote, enhance, or protect tourism or the orderly growth of the community or the commercial fishing industry, or the sport fishing industry, or the shellfish industry, or the recreation industry—and that is close to a billion dollar industry alone, just tourism—There was no conceivable way of enhancing this if we did not enhance the marine environment."

A member of the Michigan State Legislature, Raymond Smit, took a viewpoint rather closer to that of Stevens and Savage than to that of Koppelman. "In the area of pollution control," he stated, "the people of Michigan has recognized the value of their water resources and have taken a position of leadership in controlling water pollution in the Great Lakes. We have for many years issued enforcement orders against polluters. We have taken them to court, when necessary, and had excellent enforcement in our courts. In 1968, the people of Michigan voted to issue 335 million dollars in general obligation bonds so that we could finance pollution control works needed in Michigan. . . .

"Unfortunately, the misdirection of the Pollution Control bill in Congress has derailed Michigan's program. It has brought us to a standstill, has us knee deep in red tape that could only have been dreamed up in Washington. We now have a backlog of over 500 communities who find it impossible to get construction projects underway.

"Another classic example has been our conflict with the federal government over pollution control from water craft.

"Recognizing that the concentration of recreational water craft and the proximity of our shipping lanes by beaches and water supplies create a serious hazard from boat pollution, Michigan passed a law years ago to prevent overboard discharge of sewage from water craft. Our pleasure boaters have complied with this requirement almost unanimously by installing and using holding tanks and shore pumpouts connected to a sewerage treatment plant. However, we are still tied up in court with the commercial shipping interests and Congress hasn't help us a bit. They have, again, tied our hands in controlling this kind of pollution, and in spite of government promises, dumpage and sewerage is still being discharged overboard from commercial ships in the Great Lakes, creating significant hazards to the people who use this fresh water resource."

In that talk, as in many others, the question of environmental considerations balanced with economic considerations—sometimes reflected as environment vs. economy—was raised. As a corollary, the problem of adequate energy sources was on everyone's mind both as a short term difficulty in that time when the nation was experiencing a gasoline shortage, and as a long-term difficulty that would inevitably bring with it considerations of the national interest in uses of the coastal zone. Some solid facts on the energy shortage, and a persuasive view of the national interest in providing an energy component in state coastal zone plans, was put by Thomas Carr of the Federal Energy Office:

"The (Arab) boycott has abruptly telescoped the transition from an era in which we had cheap and abundant energy to one of great scarcity and much higher cost. We have been building up to this for quite some time. The demand for energy has grown between 4 percent and 5 percent a year for 20 years. Our gross energy demands, even with the maximum reduction, will be about 80 quadrillion BTU's by the year of 1975. And, by the year 2000, 119 quadrillion BTU's. Domestic exploration for petroleum products peaked in 1956. Production peaked in 1970. . . .

"As a nation, we have become increasingly dependent on foreign sources of petroleum. Prior to the embargo, we were importing about 35 percent of our total petroleum needs. . . .

"The FEO sees at this time the Coastal Zone Management Program as an opportunity, an occasion for joining our responsibilities in this challenge of effort. We therefore, request that during this meeting and after, you consider the national energy interests in offshore drillings, deep water ports, and new refining. The Continental Shelf contains about 40 percent of United States petroleum capacity. Hopefully by 1985 the outer Continental Shelf production will produce 16 percent of our oil demand and 20 percent of our natural gas demand.

"Deep water port terminals can go a long way towards reducing the delivery cost of fuel which is at present a very significant part of the cost of the imported product. The risk of grounding, which is the cause of 24 percent of the pollutant released by tanker vessels, is near zero with deep water ports, but will increase each year without them as more and more small tankers crowd into existing ports. Therefore, national policy and local, environmental and financial considerations point, we think, towards the use of these oil terminals.

Wayne Gibbens, President of Mid-Continental Oil Co., supported Carr's position succintly, pointedly. "Since 1946," he said, "over 17,000 wells have been drilled in the coast off the United States. There have been just four major oil spills from such offshore wells. And, in all four instances, no permanent damage to the environment has been sustained."

"Offshore production offers us our principal opportunity to meet future needs for petroleum and to reduce our dependency on overseas sources."
Wayne Gibbens, President, Mid-Continental Oil Co.

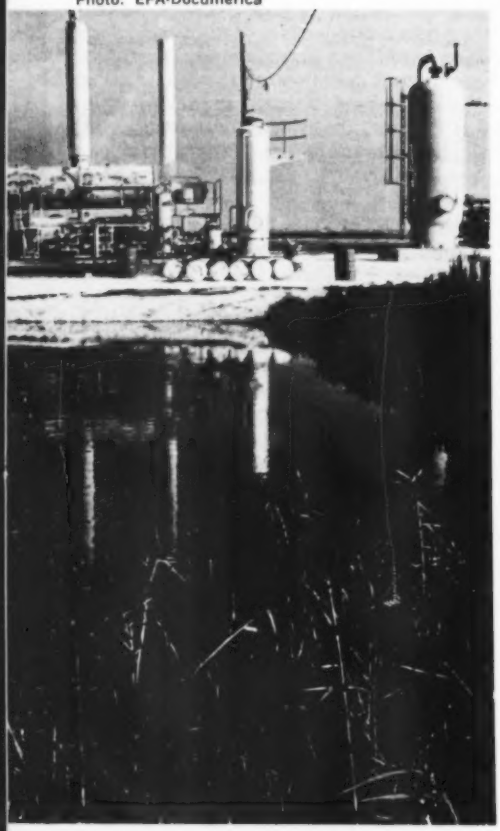
He admitted that there have been instances when some temporary damage has been incurred, and said that such experiences have unquestionably influenced public policy toward offshore exploration and development—a policy that has thus retarded development. But, he said, "the standards for judgment must be based on today's realities, not on yesterday's mistakes." He then went on:

"Offshore production offers us our prin-

Marinas offer facilities to thousands of boaters to escape land-locked pursuits.

Photo: Frank Oxley

Photo: EPA-Documerica



A problem in coastal zone management: the power plant and the marsh.

cipal opportunity to meet future needs for petroleum and to reduce our dependency on overseas sources. It takes a long time; three to seven years to drill offshore leases. Therefore, high priority must be attached to this problem."

Gibbens too, like many of those who preceded and followed him, made especial reference to the need for the people in an affected area to have a part in the decision, and their need for full information on which to base their decisions. "The people who will incur the risk should be the people who make the decision," he said, referring to the people who may feel that they are risking their own state coastline when a refinery proposal is before them. "If they determine that they don't want a refinery, hopefully, it will be an informed determination acknowledging, when it is made, that there are costs attached in the sense of missing the capital investment, in the sense of missing jobs that would be provided, tax base, and many others that you recognize."

Although Gibbens voiced the view that public policy has retarded development, Michael McCloskey, Executive Director of the Sierra Club, had a contrary perspective. Pointing out that the "finding" section of the act contains five subsections that emphasize environmental protection and three that deal with the bounds between developmental and environmental considerations—and adding to that the emphasis in the Senate Committee Report that the purpose of the act is to reduce or minimize direct significant adverse impacts upon coastal waters—McCloskey said that the Act has to work "to impose greater restrictions on what is done because presently we have a laissez-faire policy of minimum restrictions. If that were satisfactory," he demanded, "why would the federal government do anything at all?"

Pointing out the fragility of estuarine areas, he said:

"I think it is important that NOAA itself should have some framework for aiding the states in evaluating these varying qualities of fragility or rarity or vulnerability. . . . I think there ought to be ratings and evaluations on a scale of the importance of biological sources in terms of the degree of productivity for fishery purposes; the importance of resources on inter-continental flyways; analysis of the life cycles of the different species of marine organisms and their migratory patterns and how different portions of the coast fit into those patterns, identifying spawning areas, nursery grounds and so forth; analysis of where there are heavy concentrations of endemic species, unique species that may arise out of special environmental factors. . . .

"I think it is important to realize that when inventories of this sort are done, it may turn out that one state will have so many of these things that that state itself is almost of national interest."

Elvis Stahr, formerly Secretary of the Army and now President of the National Audubon Society, also underlined the environmental necessities, as he saw them, pointing out that present state and local government institutional arrangements for planning their coastal zones are inadequate. "I suggest," he said, "that each state should be required to build into its coastal zone management program a process to guarantee that every major decision that could significantly affect coastal zone resources will be subjected to a thorough analysis of its environmental impact, including a detailed examination of alternatives.

"I am not advocating a policy of no economic development, no growth. Not at all, what I am advocating is controlled growth in harmony with the natural resources of the coastal zone. It means planned, orderly growth where adverse environmental effects will be minimal or non-existent.

"It means planning ahead and determining where new residential and commercial and industrial growth should go. It means planning ahead and determining where these developments should not go. It means determining which is so aesthetically valuable that no development should be permitted.

"It means understanding that natural processes that take place in the coastal zone are vital and that they must not be destroyed, needlessly, including the food

EXXON Photo

Offshore oil wells are an increasing sight in many areas, providing the world with energy.

chain that leads ultimately to people.

"It means that estuaries deserve and require especially careful attention. . . .

"It will require political leadership on the local, state, and federal levels to recognize that we continue to play environmental Russian roulette only at a real risk to our basic life support systems.

"In short we need political leadership that understands that more is not always better—that uncontrolled growth, like any other cancer, can be destructive."

A call for growth, in ways that he believes will be environmentally sound, came from Joseph Stadelman, Vice President of Offshore Power Systems. Hearkening to President Nixon's goal of self-sufficiency in energy by 1980, he stated that a major step would be a shift to an all-electric economy with nuclear power and coal as the bases. And he dealt directly with one view of the national interest in siting facilities, as called for in the Act. "The commitment to nuclear power as an energy resource is self-evident," he stated, going on to say that because of this, close attention must be paid to nuclear power plant siting.

"Historically," he said, "many nuclear plants have been sited in the coastal zone. This trend will continue and very likely increase in the future as other demands such as the shortage of fresh water tend to drive the siting of plants towards the coastal zones.

"I think the floating nuclear plant is a case in point with respect to allocation of resources in the coastal zone. It adds a new and unique aspect to the siting of nuclear power plants. Briefly, the floating nuclear plant is an electric generating station capable of producing in the standardized plant that we are building today, 1150 megawatts, which is enough electricity to supply the needs of some 600,000 people.

"A prerequisite to the use of floating nuclear power plant to supply electricity is that it must be sited in the coastal zone. . . . The first floating nuclear power plant will be delivered in 1979. And, when this facility reaches its full maturity and full production capability it will be able to produce the nuclear power equivalent to 48 million barrels of oil a year."

When all was said and done, the plea for citizen involvement in the decisions, as a fundamental of national interest in a democracy, came from a lady from North Carolina, Marion Nichol of the League of Women Voters. "I can be very sympathetic," she said, "with the person on the agency who has done a tremendous amount of study and is bursting with the urgency of a problem and assured that he knows the solutions, and is then confronted with the problem of informing the uninitiated and accommodating other viewpoints and other interest. And yet I feel the only greater danger than taking the time to do this is to go ahead without the consideration of other viewpoints, interests, and aspirations."

She pointed out that citizens in an affected area, or in interest groups such as the LWV, are sometimes slow to hear about proposed changes, and she supported the requirement that a technical notice such as a news release be issued. "For the actual notice of the hearing," she said, "30 days is not enough, not if the hearing is on a major and complicated management plan. . . .

"There must be opportunities for people to speak to the great issues of the day."

Robert Knecht summed up the tone of the conference as "cautiously optimistic." As he sensed the general tenor of the discussions, he felt that the conferees believe that the coastal zone management act does offer the possibility of improvement of the present situation, but with three important caveats:

"Number one, that Federal agencies are sincere in their willingness to have states accept the primary role;

"And, number two, that states accept a leadership role;

"And, number three, that all the actors recognize the importance of shared responsibility in coastal zone management."

This same theme, he felt, was carried out in the evolving of thoughts about the national interest. "I think the first thing that came out to me," he said, "was that the national interest seemed to many people to be to get the states moving in accepting the responsibility to develop and lead in the management of the coastal zone—but I also heard equally strongly that it is in the national interest for the Federal Government to get its house in order." Pointing out that "we"—the conference organizers—did not say what their perception of the national interest might be, he noted that the design and object of the conference was to hear what other people were thinking. "And," he concluded, "I think that we have had such a wide range of views suggests that maybe this kind of discussion and dialogue continues to be necessary." □

"It will require political leadership on the local, state and federal levels to recognize that we continue to play environmental Russian roulette only at a real risk to our basic life support systems."

Elvis Stahr, President
National Audubon Society

NOAA WEATHER/RADIO

BY EDWIN P. WEIGEL

STORMALERT!

Elroy C. Jagler, NWS Milwaukee, tapes forecast for VHF-FM station KEC-60. (Racine Journal-Times Photo by R. N. D'Acquisto)

Proper dissemination of storm warnings is a perennial worry for the weatherman—particularly the rapid spreading of alarms to the public about fast-breaking weather events such as flash floods and tornadoes.

And, within this framework, the most urgent problem of all is swift dissemination of storm alerts to places where there are large congregations of the young, the old, the helpless, and the vulnerable—such as schools, nursing homes, hospitals, and large mobile-home communities.

After the terrifying storms of last April, when a massive outbreak of tornadoes killed more than 300 persons and destroyed more than 9,000 homes, Weather Service Director George P. Cressman said:

"The threat that frightens me most is that of a tornado hitting a school filled with children without warning. We have a good system for producing warnings, but the weak link is getting those warnings to people who need them and can't listen to radio or TV because they are busy doing other things—people such a schoolteachers and schoolchildren.

"A simple means of doing this is becoming available—the NOAA Weather Radio system. This system has the needed feature in the form of a tone alert by which all appropriately equipped radio receivers are activated when the forecaster in the weather office pushes a button. A continuous tone is broadcast for a few seconds and then the receiver volume is brought up and the storm warning is broadcast.

"If every school in the nation had such a receiver—and if we had a VHF weather transmitter reaching each vicinity—we could get storm warnings to school authorities as soon as prepared at the local weather office."

The special characteristics of this system are so important they are worth examining in detail—and emphasizing. For example, in the April 3, 1974, tornado outbreak, when dozens of twisters were creating havoc simultaneously, communications in some instances were jammed, even though Weather Service personnel did an outstanding job with the tools at hand. More complete coverage by NOAA Weather Radio would have helped because:

- It is fast—weather warnings are transmitted with the speed of light directly to anyone with the proper radio to receive them.
- It is continuous—once activated, the radio receivers broadcast the forecaster's warning over and over again, at roughly 5-minute intervals.
- It is silent when not needed—Weather Radio has only one story to tell—the weather story. Listeners hear only the broadcasts they want to hear.
- It is tough—Weather transmissions by radio are much less vulnerable to interruption or cutoff by storm than telephone transmissions. Only a storm wiping out the transmitter itself can silence the forecaster. Also, transmission by FM radio rather than AM radio makes the broadcasts free of the storm static that so often renders AM radio unintelligible during a thunderstorm.

NOAA Weather Radio broadcasts generally can be received 40 to 60 miles from the transmitter. However, blocking features such as hills and large buildings interrupt them, since VHF-FM radio by nature is line of sight—a characteristic built in by laws of physics.

The weather frequencies of 162.55 and 162.40 MHz lie above the usual, commercial frequencies, so purchasers must be sure they are buying proper receivers to get the weather broadcasts. A number of home radio sets now being sold have a special button to press to automatically tune to the weather frequency.

Most Radio Weather transmitting stations have 300 watts' power, but a program is under way to upgrade many of them to 1,000 watts, increasing range.

The Weather Radio system is a valuable servant for radio or TV stations seeking the latest forecasts or warnings. Forecasters revise the tape recordings for their VHF radio as one of the first chores to perform during weather emergencies. The Weather Service encourages taping and rebroadcast over commercial channels of these messages. This eliminates time-consuming phone calls.

Use of the NOAA Weather Radio system is not restricted to storm warnings; only the tone-alert feature is reserved for that purpose. The tape-recorded weather messages are repeated around the clock every four to six minutes and routinely revised every three to four hours—oftener, of course, during rapidly changing weather.

The special receivers to receive the NOAA Weather Radio broadcasts range in price from about $12 to $150 or more. The better the quality, the farther away the signal can be picked up.

As of July 1, 1974, about one tenth of the area of the 48 contiguous States was covered by this lifesaving system of continuous weather broadcasts, serving 44 percent of the U.S. population.

More weather transmitters are on the way. Just how many will depend on budgetary and other considerations. One thing is certain. The system will be expanded. The need and benefits are obvious.

Tornado that hit Xenia, Ohio, during outbreak of the twisters in April of this year. Tornado was about 300 yards away from Greene Memorial Hospital when photo was taken by Fred Stewart, Public Relations Director for the hospital. Hospital was undamaged, with only two windows broken.

NOAA WEATHER RADIO STATIONS BY STATE

Alabama
Mobile KEC61 162.55 MHz

Alaska
Anchorage KEC43 162.55 MHz
Seward KEC81 162.55 MHz

Arizona
Phoenix KEC94 162.55 MHz

California
Eureka KEC82 162.55 MHz
Los Angeles KWO37 162.55 MHz
Monterey KEC49 162.40 MHz
Sacramento KEC57 162.55 MHz
San Diego KEC62 162.55 MHz
San Francisco KHB49 162.55 MHz

Colorado
Denver KEC76 162.55 MHz

Connecticut
New London KHB47 162.40 MHz

Florida
Jacksonville KHB39 162.55 MHz
Miami KHB34 162.55 MHz
Panama City KGG67 162.55 MHz
Pensacola KEC86 162.40 MHz
Tampa KHB32 162.55 MHz
West Palm Beach KEC50 162.40 MHz

Georgia
Atlanta KEC87 162.55 MHz
Savannah KEC88 162.40 MHz

Hawaii
Hilo KBA99 162.55 MHz
Honolulu KBA99 162.40 MHz
Kokee KBA99 162.40 MHz
Mt. Haleakala KBA99 162.55 MHz

Illinois
Chicago KWO39 162.55 MHz

Indiana
Indianapolis KEC74 162.55 MHz

Iowa
Des Moines KEC75 162.55 MHz

Kansas
Wichita KEC59 162.55 MHz

Louisiana
Lake Charles KHB42 162.55 MHz
New Orleans KHB43 162.55 MHz

Maine
Portland KDO95 162.55 MHz

Maryland
Baltimore KEC83 162.40 MHz
Salisbury KEC92 162.40 MHz

Massachusetts
Boston KHB35 162.40 MHz
Hyannis KEC73 162.55 MHz

Michigan
Detroit KEC63 162.55 MHz

Minnesota
Minneapolis KEC65 162.55 MHz

Missouri
Kansas City KID77 162.55 MHz
St. Joseph KEC77 162.40 MHz
St. Louis KDO89 162.55 MHz

New Jersey
Atlantic City KHB38 162.40 MHz

New York
Buffalo KEB98 162.55 MHz
New York City KWO35 162.55 MHz

North Carolina
New Bern KEC84 162.40 MHz
Wilmington KHB33 162.55 MHz

Ohio
Akron KDO94 162.40 MHz
Cleveland KHB59 162.55 MHz
Sandusky KHB97 162.40 MHz

Oregon
Astoria KEC91 162.40 MHz
Eugene KEC42 162.40 MHz
Portland KEB97 162.55 MHz

Pennsylvania
Erie KEC58 162.40 MHz

South Carolina
Charleston KHB29 162.55 MHz
Myrtle Beach KEC95 162.40 MHz

Texas
Brownsville KHB33 162.55 MHz
Corpus Christi KHB41 162.55 MHz
Dallas KEC56 162.40 MHz
Ft. Worth KEC55 162.55 MHz
Galveston KHB40 162.55 MHz
Houston KGG68 162.40 MHz
Pharr KHB32 162.40 MHz

Utah
Salt Lake City KEC78 162.55 MHz

Virginia
Norfolk KHB37 162.55 MHz

Washington
Seattle KHB60 162.55 MHz

Washington, D.C. KHB36 162.55 MHz

Wisconsin
Milwaukee KEC60 162.40 MHz

The Audubon (above) and Dunn (right and below) elementary schools in Louisville, Kentucky, were heavily damaged during the April 3 tornado outbreak. Fortunately, the twister struck the buildings about an hour and forty minutes after the normal 3 p.m. school closing time.

Photos by Dick Grant, Tulsa Tribune

TORNADO SAFETY FOR SCHOOLS

Several times in recent years, schools have been hit by tornadoes. In most instances, fortunately, classes were not in session. In some other instances, where students were present, school officials familiar with twisters safeguarded the children by taking prompt action just before the tornadoes hit.

NOAA's National Weather Service urges that all schools develop plans and conduct drills to cope with tornadoes—particularly in the South and Midwest, where the threat is greatest. Tornado drills are much different from fire drills.

Among details to consider:

- Remember that the National Weather Service issues a tornado watch when the possibility of tornadoes exists, and a tornado warning when a tornado has been spotted or indicated on radar. Remember also there may not be time for a tornado warning before a twister strikes. Tornadoes form suddenly. Teachers and students should know the difference between a watch and a warning.
- School officials at the State and county level should have a plan for rapid dissemination of tornado watches and warnings to every school in the system—either by radio or telephone.
- Each school should be inspected and tornado shelter areas selected and marked. Schools with basements should use these as tornado shelters. Schools without basements should use interior hallways on the lowest floor. Under no circumstances should gymnasiums, auditoriums, cafeterias, and other rooms with wide free-span roofs be used as shelters. Teachers and students should know their designated shelter areas.
- School administrators should establish procedures governing use or non-use of school buses during tornado watches and warnings. Generally speaking, school buses should continue to operate during tornado watches, but not during tornado warnings. School buses are easily rolled by tornado winds.
- During a tornado watch, specific teachers or other school staff members should be designated to monitor commercial radio or TV for tornado warnings, even if the school has a NOAA Weather Radio tone-alert system. Other public agencies, too, report tornado sightings. Weather monitors also should keep an eye on the sky for dark, roiling clouds, hail, driving rain, or a sudden increase in wind, in addition to the telltale funnel. Tornadoes are often obscured by precipitation or darkness.
- A special alarm system should be designated to indicate a tornado has been sighted and is approaching. A backup alarm should be planned for use if electrical power fails—perhaps a battery-operated bullhorn, an inexpensive hand-cranked siren, or even an old-fashioned hand-swung bell.
- Specific teachers should be assigned to round up children on playgrounds or other outdoor areas during a tornado warning. Otherwise, they might be overlooked.
- Children in schoolrooms of weak construction—such a portable or temporary classrooms—should be escorted to sturdier buildings or to predetermined ditches, culverts, or ravines, and instructed to lie face down, hands over head. Most tornado deaths are caused by head injuries.
- When children are assembled in school basements or interior hallways during a tornado drill or warning, they should be instructed to respond to a specific command to assume protective postures, facing interior walls, when the danger is imminent. Such a command might be: "Everybody down! Crouch on elbows and knees! Hands over head!" It is essential that this command be instantly understood. Illustrations showing the protective position should be posted on bulletin boards.
- If a school bus is caught in the open when a tornado is approaching, the children should be escorted to a nearby ditch or ravine and made to lie face down, hands over head. They should be far enough away so the bus cannot topple on them. School bus drivers should be regularly drilled in tornado procedures.
- School district officials planning new buildings or additions should keep tornadoes in mind when setting construction standards. One excellent source is a new booklet put out by the Defense Civil Preparedness Agency (the former Office of Civil Defense). Write to that agency at Washington, D.C. 20301 and ask for "Schools in Kansas with Tornado Protection."

(Above) Tulsa, Oklahoma, school children are drilled in the correct protective posture.

(Left) During a tornado emergency, children should crouch on elbows and knees, facing interior walls, with hands clasped behind their heads.

Varied background serves Gordon Lill well as . . .

STRAW BOSS FOR THE SURVEY

BY RAYMOND WILCOVE

Farm boy, high school football captain, NYA worker, Navy lieutenant, college instructor, diamond hunter, corporation executive, geologist, oceanographer and public administrator.

Dr. Gordon G. Lill, Deputy Director of NOAA's National Ocean Survey, has been all that and more, but if it hadn't been for his family doctor, he might have gone into medical research.

Lill consulted him when he graduated from high school in Mt. Hope, Kansas (population 400). It was in the 1930's and the depression was on full force. The country doctor swivelled around in his chair, looked hard at young Lill and barked: "Hell, kid, you don't have enough money to go off and study medicine."

And that ended what might have been a promising medical career for Lill. But what was medicine's loss was oceanography's gain, for Lill went on to play a very important role in its advancement.

Looking back, Lill has no regrets. "I undoubtedly had much more fun getting where I am today than I would have had if I'd gone into medicine," said the NOAA official.

On the way, Lill progressed from a rawboned farm boy who still shivers at the recollection of having to milk his share of 21 cows in a barn where it was 10 below zero to a respected position in the oceanographic community and NOAA.

"It was a wonder those cows didn't give ice cream instead of milk," remarked Lill. "One winter, during a Blue Norther, the thermometer stuck at around 20 below for two frozen weeks. The storm was so bad we had to guide ourselves along a rope hung with lanterns from the house to the barn to avoid getting lost."

Lill is 56 and like many who grew up during the depression, when 12 million people walked the streets looking for jobs, he hasn't forgotten what life was like in those days.

Lill went to college in 1936 with five dollars in his jeans. His parents paid the $50 a semester fee at Kansas State College of Agriculture and Applied Sciences (now Kansas State University) in Manhattan and an older brother gave him $15 a month, which paid his $7 monthly rent in a rooming house, with the remainder for all other expenses. Aside from that, young Lill, then 18, was on his own.

"I wasn't able to get a job that first semester," he recalled. "A hamburger every now and then was about the biggest meal I had during that period." After that, Lill worked for his meals in a boarding house and restaurant, struggled for 25 cents an hour for the geology department (paid for by the National Youth Administration), earned some money during the summer recess, and floated a $300 loan. That enabled him to graduate in 1940 with a bachelor of science degree in geology.

A few months thereafter, Lill joined the naval reserve and sailed on the USS ARKANSAS to Panama as an apprentice seaman. It was the first time he had been out of Kansas and the first time he'd seen the ocean. Later, after 90 days of intensive training in Chicago as a midshipman, he received his commission as ensign.

Lill's first involvement in oceanography came in August 1941, when he was assigned to the Woods Hole Oceanographic Institution for oceanographic training. During a 90-day period at the Massachusetts facility he learned the basics of oceanography from men who later became world famous in their fields, men like Columbus Iselin, Maurice Ewing and Fritz Fuglister.

"I was one of those 90-day wonders," explained Lill. "The Navy gave us a cram course in how sound behaves in seawater, told us how to catch submarines with this knowledge, and then shipped us off prepared to do so. I am sorry to say that this worked in reverse for some of my Woods Hole classmates."

In November 1941, Lill was assigned to the 15th Naval Dsitrict in the Panama Canal Zone. "I traveled there aboard a United Fruit Company boat," said Lill. "I spent seven days, including two in Jamaica, drinking Planter's Punch. Nicest trip I've ever had; very relaxing."

In Panama, Lill found things were relaxed also. If war loomed over the horizon elsewhere, Lill found no signs of it in the 15th Naval District, nor did he believe any war was in the offing. Bored by inactivity, Lill found his bathythermographs which had been shipped earlier from Woods Hole, in a warehouse and decided to try them out on one of the four old destroyers, the gunboat and net tenders that guarded the sea approaches to the canal. But none of the COs would let him come aboard. "We don't want that blasted stuff on our ship," one growled at him.

With time hanging heavy on his hands, Lill went to Colon at the other end of the canal for a month. "I checked into the Bachelor Officers Quarters there," he recalled. "I had a good time, but I got tired of the night life in Colon and finally returned to Balboa to find that no one had even missed me."

Lill was finally assigned to the gunboat the USS ERIE, and it was abroad this ship that he heard the news of Pearl Harbor.

"It was Sunday and practically no one was aboard. I was the only commissioned officer on the ship, tied up in Balboa, when I heard the announcement on the radio. I scrounged around the ship and finally found the chief quartermaster. I said to him, 'You know how to drive this ship?' and when he said said he did, I told him to be ready to do just that in case any enemy planes were sighted."

Fortunately, the commanding officer came aboard before that was necessary and they sailed the next day looking for the Japanese. "We sailed out 500 miles and then back for two weeks," said Lill, "and I figured if the Japanese found us we were through. Those destroyers and the gunboat weren't enough protection."

The end almost came during a trip to the Galapagos Islands off Ecuador to which the ERIE had been sent to check whether the Japanese had established a base there. While there, they came across a barrage balloon which had broken loose from its moorings over the canal and had drifted there. The ERIE went over to investigate, but what it didn't know was that a Japanese submarine was lying in wait.

"Lucky for us, instead of just raising the periscope and letting us have it," said Lill,

Snapshots from Deputy Director Lill's career: newly-commissioned Ensign Gordon Lill, USNR, (upper right) in 1941 photo, and the ship on which he served, USS ERIE; (above) with NOS Director Adm. Powell; during world's first deep-sea drilling expedition, Phase I of Project Mohole aboard drill ship CUSS I (center right) with Robert Bauer of Global Marine and Walter Munk of Scripps Institution of Oceanography (Global Marine Photo); below, in a diamond mine in Africa.

"they made the mistake of breaking the surface with their conning tower and as soon as they saw us they beat a hasty retreat. What they didn't know was that our depth bomb racks didn't work." Lill vividly recalls seeing the Chief Bosun propelling a depth bomb, stuck in the rack, into the sea with his foot. "It's a wonder we weren't sunk. Luckily, the bomb failed to go off."

The ERIE subsequently redeemed itself by sinking some German U-boats in the West Indies, but then got hit itself. Lill was no longer aboard, having been transferred in the summer of 1942 to Norfolk, Va., where he was assigned to the staff of Adm. Ulysses S. Sharp, commander of the Atlantic Fleet's Service Force. "I later heard what happened when the ERIE was hit," related Lill. "The torpedo went right into my stateroom and killed my old roommate along with several others. I've been living on borrowed time ever since."

Lill spent several years in Norfolk and married his childhood classmate, Mildred Adams, from Mt. Hope, while there. By now he was a full lieutenant and figured he could afford to do so. The remainder of the war was spent in Washington in the Bureau of Ships' sonar division. Mustered out, he returned to Kansas State for a master's degree and then went to the University of California in Berkeley as a student and graduate instructor in geology.

But when he was offered a job in Washington with the U.S. Geological Survey, Lill decided to accept it. It was then that one of those little circumstances occurred that often change the course of one's life. Enroute to his new job, Lill stopped off to see Dr. Roger Revelle, whom he had known in the Bureau of Ships. Revelle was with the newly-established Office of Naval Research and Lill went to work there instead.

Off and on, Lill spent 14 years with ONR. It was a period which saw him play an influential role in the development of oceanographic and earth science institutes at various educational institutions. One of the Navy's missions during this period was to promote oceanographic research and the earth sciences and ONR was assigned the task, a job it carried out alone until the National Science Foundation and similar agencies in the Department of Defense came along.

"I spent a good deal of my time during that period," recalled Lill, "traveling back and forth around the country, visiting colleges and universities, and urging them to get involved more in oceanographic research and the various earth sciences. We made contracts. We paid for personnel, equipment, and ships and built new laboratories."

As head of the Earth Sciences Section of the Geophysics Branch of ONR and later as branch chief, Lill supervised more than 100 contracts for research in geology, seismology, gravity, geochemistry, paleontology, mineralogy, oceanography, atmospheric physics, geophysics and marine geophysics; and was chairman of the U.S. Committee on Oceanography for the International Geophysical Year (IGY).

It was during this period that Lill helped the University of Washington, Johns Hopkins University, Texas A&M, the University of Oregon, New York University and the University of Miami to establish Departments of Oceanography on their campuses. Lill was also instrumental in assisting the University of Rhode Island to re-establish its Department of Oceanography and helped Columbia University to start up its Lamont-Doherty Geological Observatory. For his work in this area, Lill received many accolades and an honorary Ph.D. from the University of Miami. He was also presented with Kansas State's Award for Distinguished Service in the Field of Science.

By this time, Lill had come to the attention of the Lockheed Aircraft Corporation in Burbank, Calif., which was trying to develop its expertise in oceanographic research. Lill spent the next four years from 1960 to 1964, as a research advisor to Lockheed, providing guidance and backup for its research laboratories. During his service at Lockheed he was appointed to the California Advisory Commission on Marine and Coastal Resources by Governor Reagan and later was appointed the Commission's Vice Chairman.

By this time, earth scientists has become interested in boring a hole through the earth's crust into the mantle—a program that became known as the Mohole Project from the Mohorovicic discontinuity that separates crust from mantle. The idea was to drill a hole to a depth of about 35,000 feet, in an ocean site where the crust is thinner than it is under the continents. The National Science Foundation asked Lill to direct the project and he did so for two years until as the costs continued to grow Congress terminated it.

Although the project folded, there were beneficial fallouts. Lill was responsible for monitoring the development, by Brown & Root, Inc., of the design for a highly stable platform that was to have been used for drilling into the sea bottom. This design was subsequently utilized by some petroleum companies in drilling for oil and gas on the continental shelf.

"The Mohole Project contributed to offshore oil development," said Lill, "and to NSF's GLOMAR CHALLENGER deep sea drilling program. Both are actively under way now."

With the demise of the Mohole Project, Lill went back to Lockheed as senior scientific advisor and from there, in May 1970, to the National Ocean Survey as its Deputy Director.

Looking back on his career, Lill has several regrets. One was not being able to find any diamonds in Africa. Lill had taken a six-month leave of absence in 1949–50 from the Office of Naval Research to conduct mineralogical surveys in Liberia. "We didn't find any diamonds," said Lill, "but we did contribute to the further development of Bomi Hill, a mountain of iron, which they've been mining ever since."

The other regret involved a seven-foot green mamba snake, a member of the cobra family. The highly venemous reptile was captured in the Liberian wilds and Lill instructed a native to skin the snake and give him its skin.

It would have made some mighty pretty shoes for my wife," he said, "but instead of skinning the snake, the natives chopped it up and ate it."

Lill is a fellow of the American Association for the Advancement of Science and of the Geological Society of America. □

A New Fisheries Program In New England

BY JOHN A. GUINAN

The New England fisheries need help! This has been known for many years, but until fairly recently, efforts to provide that help were on a piecemeal basis, comparable to fighting brushfires, or putting the thumb in the dike. Now, NOAA is attacking the problem head-on with the New England Fisheries Development Program.

The goal of the program, simply stated, is to find alternatives to the heavily fished species which have been severely depleted. These include the haddock, cod, flounders, and redfish (known in some areas as ocean perch).

The New England Fisheries Development Program is planned for three years, but this is flexible, according to NOAA's National Marine Fisheries Service. During the three-year span, government expenditures are expected to be about $2 million and the industry input will be valued at least at $1 million. Initial plans call for efforts to be concentrated on a three-pronged effort to catch, process, and market three abundant resources that are not fully utilized—offshore crabs, squid, and mixed species that are now usually discarded at sea because they are considered to have little or no value. The short term plan seeks to begin developing an industry worth $3 million per year to fishermen and processing plants within three years. A longer range goal is that at the end of five years these species, or products made from them, will be in sufficient demand to generate a $10 million per year industry.

Many Americans are convinced that heavy foreign fishing efforts in recent years are solely responsible for the sharp declines in U.S. landings, but this may not be the only reason. NMFS biologists say that in addition to overfishing, there have been what they term "spawning failures," or a failure of young fish to survive, plus other

Catch of mixed species, mostly Sea Robins, on deck of NOAA research vessel Delaware II.

factors such as ocean currents and temperatures, which may contribute to the net result of there being fewer fish to catch, and too many people from various countries trying to catch them.

Aside from biological factors, the impact of fishing fleets from some 20 different countries working the grounds fished by U.S. vessels for many years can best be measured by the drastic decline in landings by New England fishermen. In 1950, for example, total landings of fish and shellfish in New England ports were over a billion pounds. In 1973 total landings were about 524 million pounds. Some examples of the declines by species show about 158 million pounds of haddock landed in 1950, but only a little over 8 million in 1973. Ocean perch landings in 1950 were 208 million pounds but in 1973 they were only 54 million pounds.

In 1950 fishermen employed on vessels (5 net tons or more) totaled 5,927. In 1960 the figure was 4,349, and in 1970, only 3,236 were listed as employed on vessels fishing out of New England ports in Maine, New Hampshire, Rhode Island, Connecticut, and Massachusetts.

It is difficult to think of any other industry that has changed so little over the years as has commercial fishing, except for a few isolated fisheries such as those for tuna and shrimp, centered in other parts of the country. Much of the fishing out of New England ports, and some other areas, is representative of the fishing methods that have prevailed along the eastern seaboard for decades. This is part of what the New England Fisheries Development Program hopes to correct.

In July 1973 the Fisheries Service appointed a program manager, Warren F. Rathjen, to serve as coordinator between the Federal Government and the other participants in the program which include representatives of the fishing industry, State agencies, the National Science Foundation, NOAA's Sea Grant Program, as well as various universities and individuals who can make effective contributions to the program. Rathjen has been in the Federal service since 1956 and when appointed to manage the New England Program was a fisheries biologist at the NMFS Fisheries Center at Woods Hole, Mass. (site of the first U.S. Government fisheries research laboratory). He also has considerable experience in fisheries development activities in the United States and in the Caribbean area as a program manager for a fisheries program funded by the United Nations.

Rathjen established his headquarters in the NMFS Regional Office for the Northeast at Gloucester, Mass., and went to work. An initial Federal contribution of $400,000 was earmarked and several advisors were named to represent industry in the program. They include Hugh O'Rourke of Boston and Jim Ackert of Gloucester, co-chairmen. Other advisers are Octavio Modesto, New Bedford, Mass.; Charles Stinson, Prospect Harbor, Maine; Jake Dykstra, Point Judith, Rhode Island, and Gayle Charles, Provincetown, Massachusetts. All are well known in local, national, or international fisheries circles and have strong records as men who get things done.

Allocation of the funds is directed by industry, through its representatives to the program. They determine what efforts will be funded and how much effort and support each program will receive for the benefit of the entire New England area. NOAA cooperates with industry in every way possible, as requested, but industry representatives have the principal say on all project activities. NMFS, however, retains the right of final approval.

Among the NOAA-NMFS elements cooperating in the plan are the Atlantic Fisheries Products Technology Center, Gloucester; the Northeast Fisheries Center at Woods Hole; and the marketing, surveillance, statistical, extension, and administrative personnel of the NMFS Northeast Region. The New England industry has demonstrated its willingness to contribute vessel time, use of equipment, and facilities and labor.

Rathjen is confident that the problems can be solved, although there are a number of hurdles to be overcome. As a group, fishermen are traditionally reluctant to move into unproven fisheries and frequently slow to adopt new methods. There is a lack of adequate holding and processing facilities for the species involved and the capital for acquiring the facilities is lacking, too. Also, there is a reluctance by consumers to accept new species.

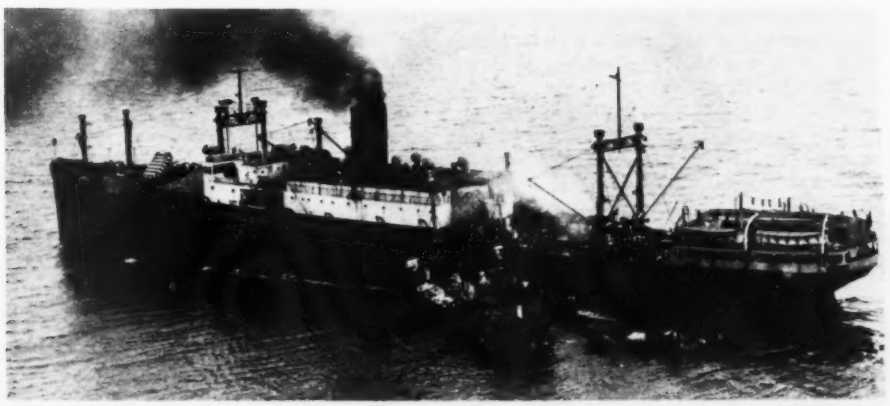
Rathjen has estimated that full use of fish now caught, but not brought ashore because of low value or little market acceptance, could add significantly to the earnings both of vessel owners and fishermen.

The resources chosen for development in the initial years of the program were selected because experts in the field believed these fish can be caught by existing vessels with minimum gear modification and the obstacles to developing viable fisheries do not appear to be insurmountable.

He says that perhaps 50 to 75 million pounds, about 20 to 30 percent of current trawl landings, now are thrown overboard. Discarded species often include small silver hake, red hake, small butterfish and flounders, ocean pout, dogfish, and several other species. These are the "mixed species."

Each "underdeveloped" stock of fish has a unique set of problems, varying in mag-

Typical foreign factory vessel in northwest Atlantic. Soviet ships usually use entire catch, a goal of the New England program.



nitude, but generally related to the economics of harvesting and processing. Efforts under the New England Fisheries Development Program are tailored to the needs associated with each species, and include reviews of existing information on availability of the species and harvesting technology to establish optimum catch rates. New approaches are being sought for mass handling techniques and sorting methods, both on vessels and at processing plants and new, efficient methods of preparing established as well as new products are being investigated. Marketing studies are being made to determine the acceptance of various product forms in domestic and export markets.

New Products or Product Forms

The possibilities of new product forms should not be overlooked, and it is interesting to note that it was in Gloucester, Mass., in the mid-1920's that Clarence E. Birdseye developed and perfected his work on quick frozen foods which have had such a tremendous impact on the entire food market. Only a little over 20 years ago, Birdseye developed frozen fish sticks which have had a revolutionaly effect on fish marketing. His firm was later taken over by General Seafoods Company, which in turn became a subsidiary of the Postum Company, which later emerged as General Foods. Veteran food technologists such as John Kaylor of the NMFS Atlantic Fishery Products Technology Center at Gloucester point out that many of the 6,000 or more items now displayed at many supermarkets, especially fishery products, were unheard of as recently as five or ten years ago.

If new markets can be found for the species mentioned earlier, it will, of course, mean more money in the fishermen's pockets. Rathjen pointed out that an increase of one percent a year in landings for 10 years would mean perhaps another $4.2 million to the fishermen and vessel owners in New England, and a 3 percent increase per year could be worth nearly $18 million in 10 years. No one in NOAA or in the fishing industry claims the New England Program is a panacea for the ills confronting the industry, but it is a start. It is breaking new ground, and demonstrating more cooperation between industry and NOAA than has been visible in New England in the past decade.

There have been estimates, although no one knows for sure, that 10 to 20 million pounds of Jonah crabs could be taken annually, with a potential value of perhaps $5 million to the fishermen. They are found from Nova Scotia to the South Atlantic States, but appear most abundant from Georges Bank, off the State of Massachusetts, to Cape Hatteras, North Carolina. Because of its wide range, some suggest that the Jonah crab resource is substantially more abundant than the red crab. The Jonah crab has scarcely been exploited commercially, primarily because the processing facilities do not exist for mass production and because of disinterest by the fishermen. This species is commonly caught along with lobsters, and the few fishermen who fish exclusively for Jonah crabs in New England often used modified lobster "pots" or traps rather than crab pots.

The red crab ranges from southeastern Nova Scotia to the West Indies and is abundant on the continental slope off the Middle and North Atlantic States. This species has not been fished heavily in the past because of the lack of processing capabilities, its inaccessibility (deep water), and because there is no established market. The red crab is commonly caught along with lobsters in deep water. Rathjen says there are many questions that must be answered concerning the potentialities in all three of the fisheries he is most concerned with these days, but with red crabs, the most important questions may well be how large is the resource and will it be able to stand heavy fishing? NMFS biologists at Woods Hole estimate that 5 million pounds per year might be taken from Maine to North Carolina without causing a decline in the stocks.

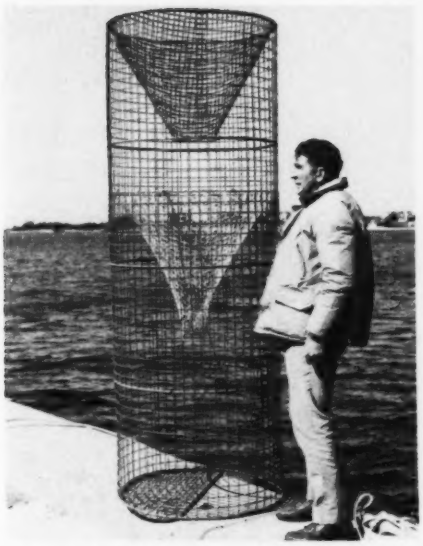
Kevin Allen, the NMFS marketing coordinator for the Northeast Region, says that limited marketing efforts with red crab last year in conjunction with a New Bedford, Mass., organization "far surpassed our initial expectations." Allen has predicted that the jonah and red crab fisheries can easily maintain an annual sales volume of 2 to 2.5 million pounds of processed product in the area from Baltimore to Boston if packaged according to buyer's portion-control specifications. To obtain 2 to 2.5 million pounds of processed product would require about 10 to 12.5 million pounds of dockside landings. Allen added that because these crabs are new items they should be introduced at a lower price than the already popular dungeness and king crab. He said red and jonah crabs are not a substitute for dungeness or king crabs, but stand on their own because of the good flavor of the meat. He also pointed out that their meat can be used as an "extender" with either of the other two crab products.

Two pilot plants, one in New Bedford, Mass., and one in Point Judith, R.I., have been processing Jonah and red crabs with technical assistance from the New England Program. In the case of red crab, a ready market appears to exist, however, with squid, the evidence is that considerable market work is needed.

Although U.S. east coast fishermen have never taken squid except as incidental to other catches, foreign vessels have found squid a paying proposition in New England waters since the late 1960's. Squid has long been popular with Mediterranean, Oriental, and Mexican cooks. Two species of squid with commercial potential are found along the Atlantic coast, long fin and short fin. Rathjen says the long fin variety is the most desirable in terms of existing markets. He estimated that current foreign catches of squid may average close to 10 tons per vessel per day. On smaller domestic vessels, he adds, a five-ton a day average would be necessary to maintaisn a viable operation. Rathjen pointed out that almost the entire squid is usable as a food product with the exception of the viscera and beak.

While the primary emphasis of the marketing aspect on squid will be to develop the export market, Rathjen said he also hopes that "some effort can be put into exploring domestic possibilities." It is encouraging to note, he said, that during the period from 1970 to 1973 east coast production of squid has doubled, from just

Deep sea red crab (l.) and shallower-water Jonah crab, two species in which interest is increasing.



Warren F. Rathjen, Program Manager, examines experimental fish traps at Woods Hole, Mass.

Long-fin squid taken by charter vessel Valkyrie, *in market development effort.*

over 1 million pounds, to well over 2 million in 1973. Early this year, the New England Fisheries Development Program chartered a New Bedford vessel, the VALKYRIE, and 24 days' fishing near the Hudson Canyon in an area known as the New York Bight produced 168,000 pounds of squid. All things considered this was about equal to foreign catches. Some was prepared for sale in Europe and some entered the domestic market. At the moment, there are now hard data on the amount of squid that may be available in New England waters, but its value as a food in this country has never been fully realized, and it is considered an underharvested resource. The long finned variety is found from Nova Scotia to the Gulf of Mexico. It is essentially a creature of the Continental Shelf and is found in coastal waters off New England from May to November, and in deeper water for the remainder of the year. The short finned species ranges from Newfoundland to south of New England where a rapidly developing fishery has been built up by the Spanish, Japanese, Italians and Poles. Fishing by the Japanese for this species has included the use of lights to attract and collect these animals. The New England Program includes similar studies during the spring of 1974 to learn more about the availability of squid using this method. The studies include a contract with Rhode Island University.

Wherever trawling operations are conducted along the Continental Shelf throughout New England waters, a substantial part of the catch is thrown overboard because it is not worth while to bring it in. At some ports the fish are brought in for industrial uses such as making fishmeal. At other locations, the species not now used for human consumption are taken ashore for pet food, and more recently using some of these varied species as food in zoos and acquariums is receiving increasing attention.

Recent progress in more effectively separating fish flesh from the "frame" or skeleton has made it possible to recover more of the edible product. This process opens a potential for extensive use as food of a variety of species now discarded or used for purposes other than human food.

The New England Program is looking toward developing a method for handling bulk catches of fish at sea, part of which may be used to make fish blocks. These are frozen blocks of fish flesh from which fish portions and sticks can be produced. Current plans call for a vessel to be adapted for these experiments this year. Research is needed, too, to develop an automated system to "head and gut" large quantities of small, irregular sized fish and to sort them into groups.

Rathjen says that if efforts along these lines seem practical, it would appear that a large portion of the catch now discarded or sold for industrial purposes may become available as food fish, raising its value to five times that of fish used for industrial purposes. He said that if the research is successful, the potential income to the New England trawler fleet could increase dramatically.

Asked to "look down the road" toward where the program may be at the end of 1974, Rathjen said he looks forward to:

Long-fin squid, a popular food item abroad.

—Regular landings of red crab

—A catalog of mixed species

—Advances in the commercial feasibility of holding techniques

—Establishing the availability of squid

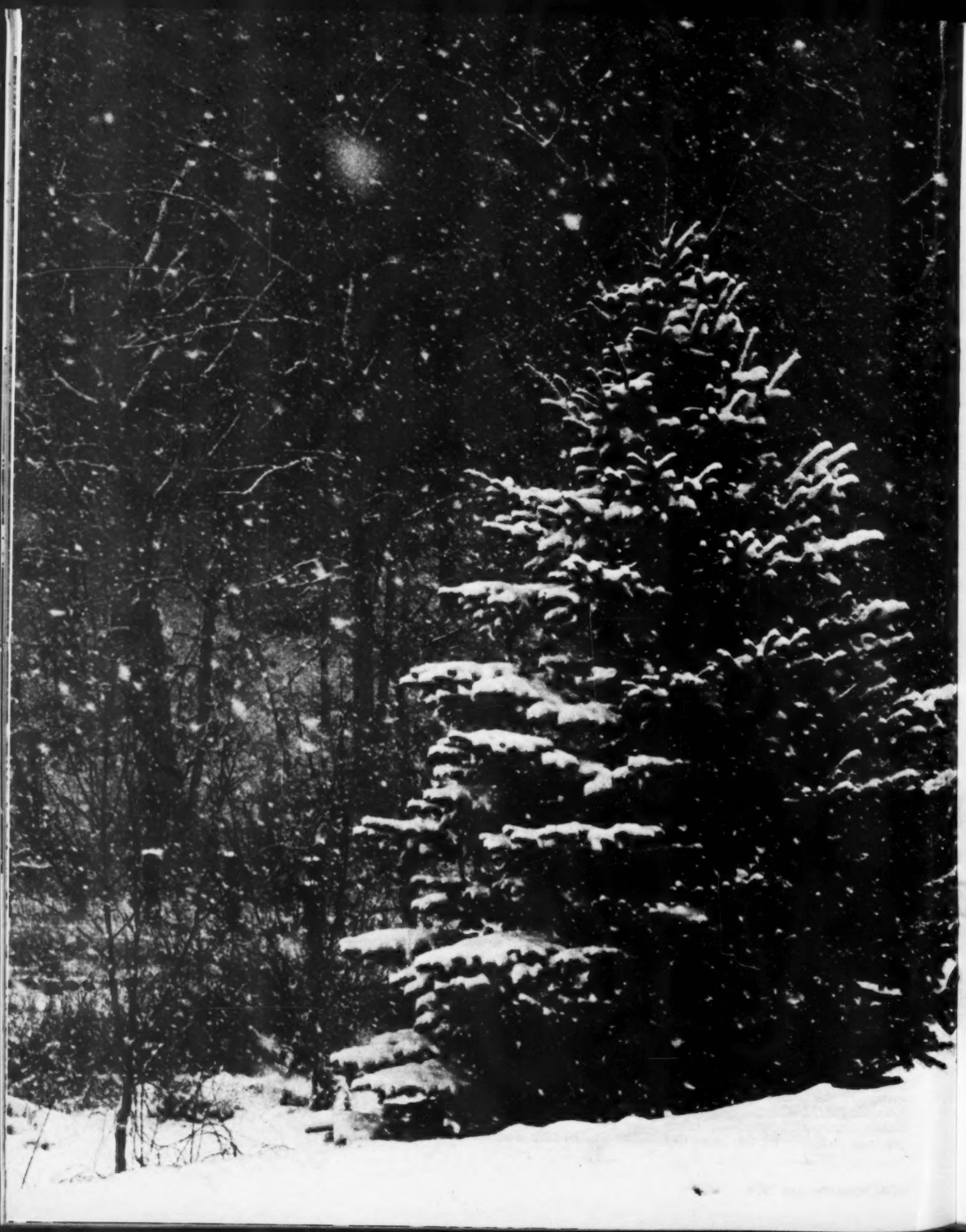
—Monitoring of new fisheries development

—Increased landings of mixed species

—Increased utilization of domestically caught species.

It is widely agreed that most traditionally fished stocks found off our northeast coast are now harvested near or beyond their capacity to sustain themselves. It follows that any new potential to support growth should come from "underdeveloped" fisheries resources. And in most cases, harvesting these species requires a financial risk, adding fishing effort, plus new processing technology and marketing. These skills must be merged into a coordinated thrust, and it is this approach which best describes NOAA's work in the New England Fisheries Developmental Program.

Industry representatives and fisheries administrators are deeply concerned that these developing fisheries should not go the way of the traditional fisheries such as the haddock, cod, flounder, and ocean perch. They agree that a rational management plan must be developed to establish harvest regulations and to control fishing effort at a level that can be sustained by the currently under-utilized resources. Interest in resolving the international situation is focused on the outcome of the Law of the Sea Conference in Caracas and actions proposed by the U.S. Congress. Steps to bring about domestic conservation also are underway in the NOAA supported State-Federal Fisheries Management Program. □



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The Microscopic Side of Weather

BY CARL A. POSEY

Over the Great Plains, dry hot air off the solar hotplate of the American southwest flows against the hot, moist circulation being drawn inland from the Gulf, and energy exchanges go off like meteorological bombs over the grasslands and southern forests of tornado alley.

Farther north, a seasoned meteorologist analyzes an incoming mass of Pacific air, and constructs a forecast that is correct on all points—except that area rainfall greatly exceeds his expectation.

Over southern Florida, scientists bombard tropical cumulus clouds with silver iodide crystals, trying to wring more rain from merged clouds than nature would.

Elsewhere, researchers try to seed the violent spiral of a hurricane into something more tolerable to coastal dwellers.

Problems concerning the mathematical movement of water through the atmosphere plague the wiry mind of a weather-simulating computer.

And in the smoky atmosphere downwind of a major industrial center, patterns of rainfall seem different from what they were when everyone was younger.

These scattered, hypothetical situations share a preoccupation with how water and the huge amounts of energy it carries are transported through the atmosphere, and how they shape our weather. In each instance, the behavior of water in the atmosphere, and the way nature manipulates that water to produce precipitation, are central.

These are also central features of an ambitious program conducted by the Atmospheric Physics and Chemistry Laboratory, one of NOAA's Environmental Research Laboratories in Boulder, Colo. There, the panoramic view required to see atmospheric systems whole is being turned around, so that scientists can look back through the telescope toward the tiny particles and processes at the heart of the mechanisms by which atmospheric water becomes precipitation.

The key process is one called "nucleation," an incompletely comprehended chain of chemistries and events that accounts for the observed formation of precipitation in both the natural and man-modified atmosphere. Nucleation theory states that water in liquid form may exist in the atmosphere at temperatures far below freezing, unless a solid "ice nucleus" is introduced on which supercooled water droplets can coalesce and freeze. In natural precipitation, these platforms are believed to be sea salts, dust from the earth's great desert and mountain areas, the particulate output of fossil-fueled industries, and other suspended solids, or aerosols, in the atmosphere. In man-generated precipitation, the nuclei are silver iodide crystals.

But nucleation is one of those scientific keystones that fits so well it must be believed—no one has observed the microscopically small events which constitute nucleation. Thus, the process by which water contributes its unique properties to driving cloud systems, storms, and the global heat engine of the atmosphere itself, cannot operate without help from the particles called ice nuclei, and nucleation, a process no one fully understands.

The importance of conducting a systematic look into the microscopic side of weather was emphasized during the Boulder laboratory's earlier work over the Great Lakes, when lake-effect snow storms were seeded with an eye to a more equitable distribution of their enormous loads of snow on the downwind shores. A by-product discovery of the project was that industrial cities—for example, the densely populated western shore of Lake Michigan—were also inadvertently seeding lake weather systems with aerosols from auto exhausts, steel-mill smokestacks, and other sources—and changing the weather downwind.

"We had reached a level of experience," says Dr. Helmut K. Weickmann, director of the Atmospheric Physics and Chemistry Laboratory, "where we could modify the precipitation processes within a given cloud or storm system, and be able to predict, within reasonable limits, what our effect on precipitation would be. In the weather modification community generally, this capability has been realized in the last few years.

"But what we lacked was any useful amount of information on the natural levels of ice nuclei present in the atmosphere. Because the effects of this natural ice nuclei population on weather—and on weather modification experiments—can be profound, we are undertaking our present investigation."

This investigation, like the tiny crystalline objects it studies, is many-faceted. First, it seeks to develop a climatology of natural ice nuclei levels, how these vary with geography and season, and how they affect weather and climate. Then, it is examining the elemental composition of ice nuclei to determine possible relationships between composition and meteorological significance, and between composition and the ups and downs of urban air quality. It is also looking at the nucleation process as it occurs in nature, to determine how nature produces precipitation as efficiently as she does—and what man can do to improve on it.

Last year, the Atmospheric Physics and Chemistry Laboratory began the first systematic effort to monitor the natural populations of ice nuclei and how these populations vary with season, weather conditions, and geographic location. To do this, a 19-station ice-nuclei concentration benchmark network was established at facilities of NOAA's National Weather Service across the western United States, at locations chosen for the comparative absence of man-generated ice nuclei. The instruments at the field sites pump about 300 liters per day of air through thin membrane filters, which are removed daily and mailed in groups to a central analysis facility in Boulder.

"We can't see the nuclei on the filters we receive from the field," says Paul Allee, the NOAA physicist who leads the benchmark project, "so we have to make our count indirectly. We place the filters in a water-vapor-saturated cold chamber and activate the ice nuclei by causing ice crystals to form on their surface; and then we count the ice crystals formed on each filter."

Here one finds one of the unknowns in the nucleation process. "As we reduce temperature in the cold chamber," Mr. Allee says, "we get more and more ice nuclei for any given filter, at least down to a point. For example, at minus 20 degrees Celsius we get about 10 times the number of ice nuclei for any given filter that we do at minus 15 degrees. We hope this study will help us explain why."

During the course of the year-long study,

some 8,000 filters will be activated and their load of microscopic ice nuclei counted, and the information punched onto computer cards. Subsequent study will search for links between ice nuclei levels and such weather elements as temperature, sky cover, precipitation, pressure, wind, and sunshine. Mr. Allee also hopes to be able to isolate some of the nuclei for chemical analysis, to determine how nucleus composition varies with time and location.

It is a large study, and it will be a while before all the hand- and eye-work of a thorough analysis can be completed. But in a preliminary report issued a few months ago, Mr. Allee had already noted several interesting preliminary results:

—Ice nuclei concentrations appear to increase in direct proportion to the distance from the coast.

—If the source of ice nuclei is the earth's surface, preliminary calculations indicate that about two ice nuclei per square meter are generated per minute. (Atmospheric concentrations at a temperature of minus 20 degrees Celsius are of the order of one nucleus per liter of air.)

—Human activity has a critical effect in some locations. For example, high-ice-nuclei levels for Lander, Wyo., probably resulted from the dust kicked up by a July rodeo.

—Monthly average values for several consecutive months from spring to summer indicate that ice nuclei concentrations have been increasing at all stations except Lihue, Hawaii, possibly a seasonal phenomenon.

—Winter snow cover reduces the nuclei numbers, apparently by sealing off the source underneath the snow.

Dr. Farn P. Parungo covers the invisibly small world of the nuclei themselves, using a newly developed miscroscopic method to study this hidden terrain. The miscroscopic scanning technique adapted to cloud physics by Dr. Farn P. Parungo and Dr. Rudolph F. Pueschel, who leads the study for the Boulder laboratory, permits investigators to "visualize" particles smaller than 250 Ångstroms (an Ångstrom is a ten-billionth of a meter) and analyze all except the very light elements contained in the particle.

The system works by scanning the specimen's surface (which is simultaneously "mapped" on a television monitor) with a collimated field emission electron beam. Because the scanning electron microscope operates by bombarding the specimen with an electron beam, characteristic x-ray photons are a byproduct of the scanning process, and can be analyzed to determine the elemental composition of the nuclei being scanned.

According to Dr. Parungo, the electron microscope-x-ray analyzer method holds great potential for atmospheric studies.

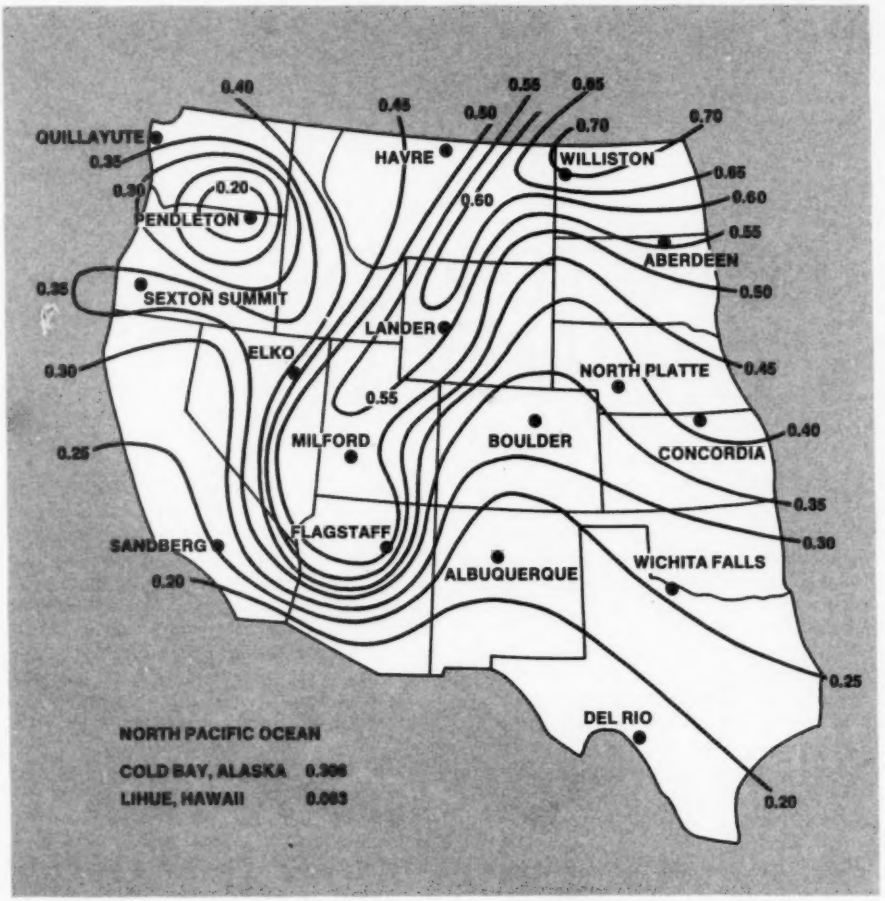
"With this relatively simple, extremely accurate technique," she says, "we will be able to determine ice nuclei sizes, shapes, and chemistries and how they vary from hour to hour, day to day, season to season. This will tell us much about how the natural atmosphere produces precipitation, and how efficiently.

"It will also permit us to investigate changes in ice nuclei chemistry caused by man. For example, we will be able to correlate observed changes in ice nuclei chemistry in urban areas with such variables as rush-hour traffic emissions, weather conditions, and the like.

"As far as deliberate weather modification is concerned, this method of analysis gives us our first opportunity to examine thoroughly the interactions between silver iodide seeding agent and the precipitation particles, and to define the precipitation-forming efficiency and environmental consequences of cloud seeding."

She has also been studying, in cooperation with Dr. Weickmann, this natural precipitation-forming efficiency as it is expressed in the manufacture of ice crystals. For this study, crystals are manufactured in various conditions of temperature and humidity in a cold chamber, then examined under the scanning electron microscope.

Writing in the German publication, *Contributions to Atmospheric Physics*, the



A 19-station network was established at facilities of NOAA's National Weather Service to monitor atmospheric concentrations of ice nuclei. Contours connect points of equal concentration, obtained for a temperature of minus 20 degrees Celsius, and indicate an increase in ice nuclei levels as the atmosphere flows eastward across the continent. Measured values shown are about one-fourth of actual values.

(Left) Richard Proulx of APCL examines the acoustic ice nuclei counter in the "Sniffer" trailer (bottom), a modern laboratory on wheels used to monitor aerosols and other weather elements in various locations. (Below) Standard weather instruments atop the trailer measure wind, temperature, and humidity, while the tube at right collects air samples from which aerosols are filtered for analysis.

NOAA scientists report that temperature and size of the water droplet were strong determinants of what the crystal finally looked like. At certain temperatures, the smaller drops tend to freeze into single crystals, while the larger ones become polycrystals. On the other hand, drops of a given size will freeze as single crystals at warmer temperatures and polycrystals at colder temperatures.

At temperatures above minus twelve degrees Celsius or colder than minus twenty degrees, crystals usually assume the shape of hexagonal columns. Between minus twelve and minus twenty degrees, a sandwich of two hexagonal plates or dendrites with a droplet in-between, or a single hexagonal plate encircling a droplet, result from a droplet frozen into a single crystal, while a droplet frozen into a polycrystal will initiate the formation of a spatial dendrite.

In a related investigation of snowflake formation in the natural atmosphere, Dr. Weickmann, writing with Dr. J. E. Jiusto of the State University of New York in the *Bulletin of the American Meteorological Society* notes that most snowflakes take

Home is Only 7,000 Miles Away

By Joan Vandiver Frisch

How do a Chinese wife and her Filipino husband avoid a culinary crisis in their marriage when neither cares for the other's native cuisine? They compromise by settling in the United States and eating American food.

So goes the life of Dr. Farn P. Pwu Parungo, a research chemist for the Atmospheric Physics and Chemistry Laboratory of the Environmental Research Laboratories, who met her husband while both were in graduate school at the University of Colorado here in Boulder.

The former native of Anhwei province in central mainland China moved to Taiwan with her parents and family after the civil war in 1949. The fifth child in a family of ten children, Dr. Parungo was reared in an atmosphere which stressed the importance of education. Her mother was a fine arts teacher in elementary and junior high schools and her father, a school district superintendent.

"Education for girls in mainland China and Taiwan is really more equitable than in America," Dr. Parungo says. "If a girl really wants to go on to graduate school or learn a profession, she has the same opportunities as a boy. Government scholarships based only on academic excellence are available for both. Consequently there are many more women doctors, scientists, and engineers in our country than in the United States."

After graduating with a B.S. degree in chemistry from the University of Taiwan, the NOAA scientist came to the United States to obtain her Ph.D. from the University of Colorado. She also attended Cornell University in Ithaca, N.Y., for an additional year of post graduate work in 1962.

Five of Dr. Parungo's brothers and sisters also left Taiwan to study abroad. Her sister, Yih, received a Ph.D. in physics from the University of California at Berkeley and now teaches at Manchester University in England. Another sister, Jean, obtained a M.S. degree in computer sciences at the University of Minnesota in Minneapolis. And her sister, Mary, was trained as a nurse at St. Mary Corwin hospital in Pueblo, Colo.

But not all of her brothers and sisters came to the United States for further education. Her brother Li-Chi received a Ph.D. in physics from Manchester University in England, and another brother, Ben-Yue, obtained a M.A. in social sciences from St. Francis Xavier University in Antigonish, Nova Scotia, Canada.

In addition, Dr. Parungo has a sister, Peggie, who teaches in Hong Kong, and another brother, Ben-Lin, who is an electrical engineer in Taiwan. She also has a sister, Yee-Sha, who chose to remain in mainland China. Thus, the NOAA research chemist's family is scattered over six countries of the world.

Dr. Parungo has not been back to Taiwan since coming to the United States in 1956. She and her husband, Benjamin, are both American citizens now.

"Both of us feel we would have more professional opportunities in America than if we returned to our native countries," Dr. Parungo explains. "And we like it here. Americans are much more frank and open to criticism. In China, the people are too worried about 'saving face.' And when my husband and I both graduated from the University of Colorado, I didn't want to live in the Philippines and he didn't care to go to Taiwan. So we've made Boulder our home."

Before joining the Environmental Research Laboratories in 1970, Dr.

Parungo spent five years studying organic aerosols and ice nuclei at the National Center for Atmospheric Research. From there she joined E. Bollay and Associates, working on chemical analysis of cloud-seeding effects in weather modification studies and air pollution.

"I really enjoy my work," she says. "It makes me feel I'm accomplishing something. And my two older children are both old enough to be interested in my work. I've brought both Paul, who's 10, and Irene, who's 8, down to the laboratory here to show them what I'm working on. Children are so much more sophisticated concerning science than when I was in school. However, Cherie, my youngest daughter who's 3, is not quite to that level yet."

Working mothers have been given more incentives to continue their careers in Taiwan than in the United States, however. Large companies provide day nurseries nearby for children of working families so that the mothers can continue their professions and still visit their children during lunch hour. And for the past 40 or 50 years women have automatically been given 40 days' paid maternity leave if they are employed by the government or schools.

"In many ways the women's liberation movement in the United States is far behind those of Europe and China from a professional standpoint," Dr. Parungo says. "Equal pay for equal work has long been the rule in those countries, while in the United States the idea has just recently been enforced.

Furthermore, women in Taiwan generally do not give up their family name after marriage and if they are in professional positions, Chinese women are addressed by both sexes as "chansen" meaning "sir." Equal representation for women in elective offices has also made far greater progress than in America. For the past 30 to 40 years, the Taiwan government has reserved a certain quota or percentage of seats in the unicameral legislative body which must be filled by elected women delegates for the customary four-year term.

"I think my husband and children have both benefited psychologically from my working," Dr. Parungo says. "My husband spends more time with them than most fathers do here or in China, and has had the opportunity to build a much closer relationship with our children. We hope they will all feel the advantages of being a working mother outweigh the disadvantages. Only time will tell."

forms less attractive to our eye than the lacy, star-like stereotype, which is not, it turns out, the best producer of precipitation.

Snowflakes may begin as the familiar, flat, individual crystals, they explain, but most crystals continue to grow after forming within the cloud, either by collecting supercooled cloud droplets, (or "riming") or by colliding with and sticking to other snow crystals. The "classic" snowflake is most likely to occur on the passive edges of vigorous storms or during periods when a storm is just developing or decaying.

Whatever the crystal-growth process, they say, nature's objective seems to be to produce the greatest amount of precipitation from a given cloud. Where there are large amounts of precipitable water but few freezing nuclei, such processes as riming and growth of new branches from rimed droplets increase the amount of moisture that can be scavenged by a single crystal. In clouds where freezing nuclei are plentiful, the many individual crystals collide and form aggregates.

They conclude: "Only when nature has exhausted all these growth processes, and still has not succeeded in scavenging much of the potential moisture, does artificial seeding have prospects of enhancing precipitation."

But in some respects at least, the inadvertent effects of man's increasingly significant contribution to atmospheric aerosols outweigh the possible consequences of what he can do deliberately. In this region of the laboratory's study, experimenters are trying to determine how a particle's chemistry, size, water solubility, and surface structure equip it for the role of ice nucleus, and how these characteristics are linked (if they are) to its importance as a changer of weather and climate.

Because these poorly understood relationships are dramatically visible in urban areas, the investigators have undertaken to use Denver's "brown cloud," an ochre pall which afflicts the Mile-High city during serious air-pollution episodes, as a source of nuclei for a mobile laboratory familiarly called the "Sniffer." This trailer-contained unit is equipped to make standard aerosol measurements and provide a continuous record of changes in the nuclei population. Aerosols collected by the Sniffer unit are subjected to scanning electron microscopy and X-ray analysis back at the Boulder laboratory. The mobile system is also used to collect filter samples for the ice nuclei benchmark project.

Thus far, only one season has been anything like fully analyzed. Last summer, the mobile unit was located within the South Platte river valley on the northeast edge of Denver in an area affected by pollution trapped beneath a low-level inversion. Preliminary results of this study, reported by Drs. Pueschel and Parungo, and Charles Van Valin, suggested that, on the backdrop of silicaceous aerosols one would expect near the Rockies, human activity writes an interesting daily record.

"We found," Dr. Pueschel says, "that almost one hundred percent of the particles samples contain aluminum and silicon. A significantly smaller proportion of the particles contain calcium, without this element varying much with time.

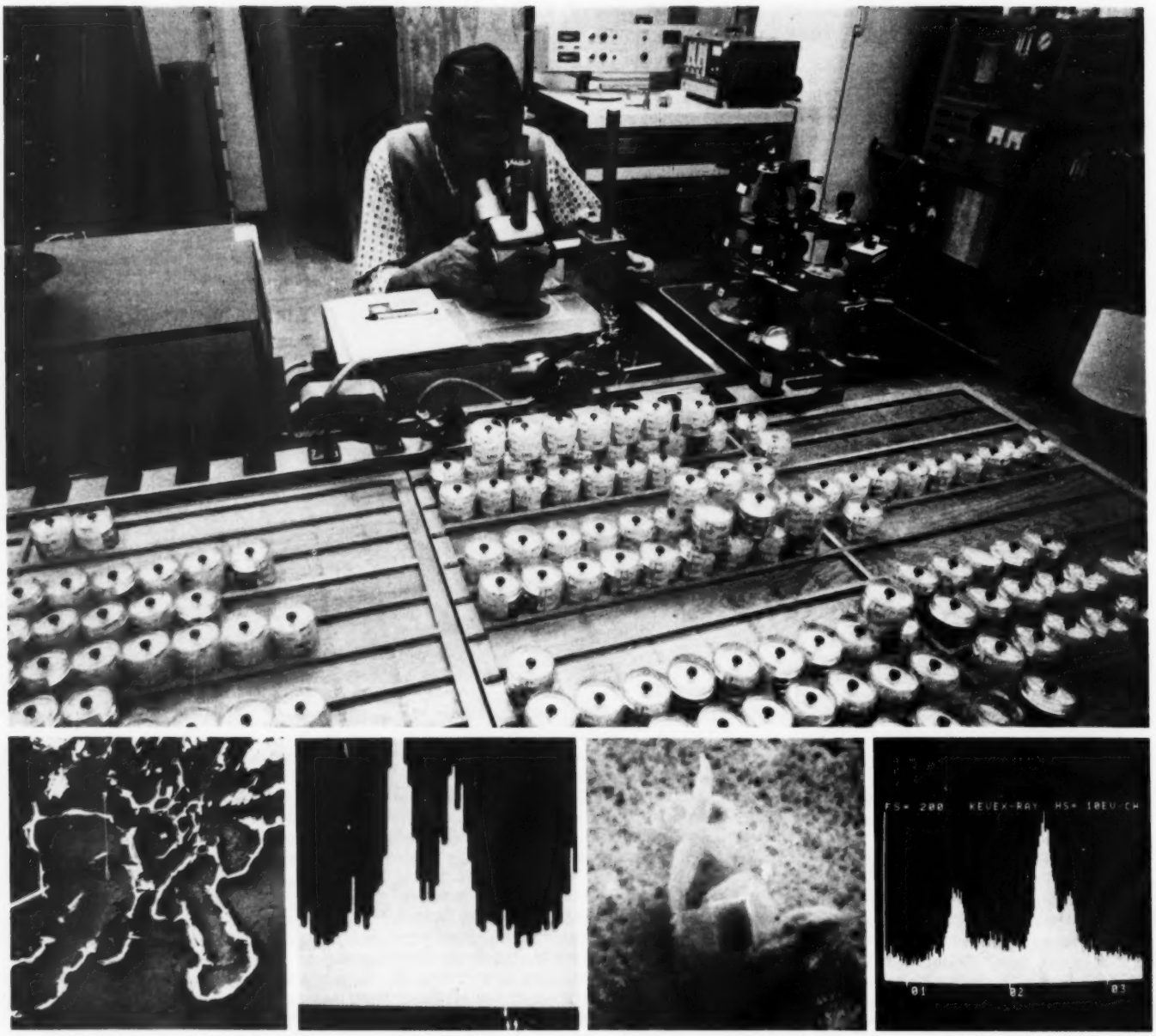
"On the other hand, the fraction of particles containing lead, sulfur, and chlorine, are subject to strong variations with time, with apparent peaks during rush hours. Undoubtedly, most of these three elements found during a pollution episode resulted from human activities. Lead and chlorine, for example, are found in leadbromochloride, a component of particulate automobile exhaust. Sulfur-containing particles are probably sulfates from a gas-to-particle conversion process from sulfurdioxide to sulfur tetroxide.

The investigators found that the leadbromochloride and sulfur-containing compounds appeared to convert otherwise inert mineral dust particles into active cloud nuclei, suggesting that such a mechanism could also link other types of pollutants and the atmospheric cloud nuclei budget. The increased ice nuclei activity they observed—this activity typically peaked around midmorning—was attributed to adsorption on the mineral particle surface of lead halide particles. The rapid decline in ice nuclei activity toward noon was attributed to photolytic decomposition of the "activated" nuclei, or to a lull in traffic, which would reduce the formation of ice-nucleating lead compounds from automobile exhausts. Also, the temporary increase in the surface solubility and capillarity of naturally produced insoluble clay particles was believed to affect the removal mechanism of pollutants from the atmosphere.

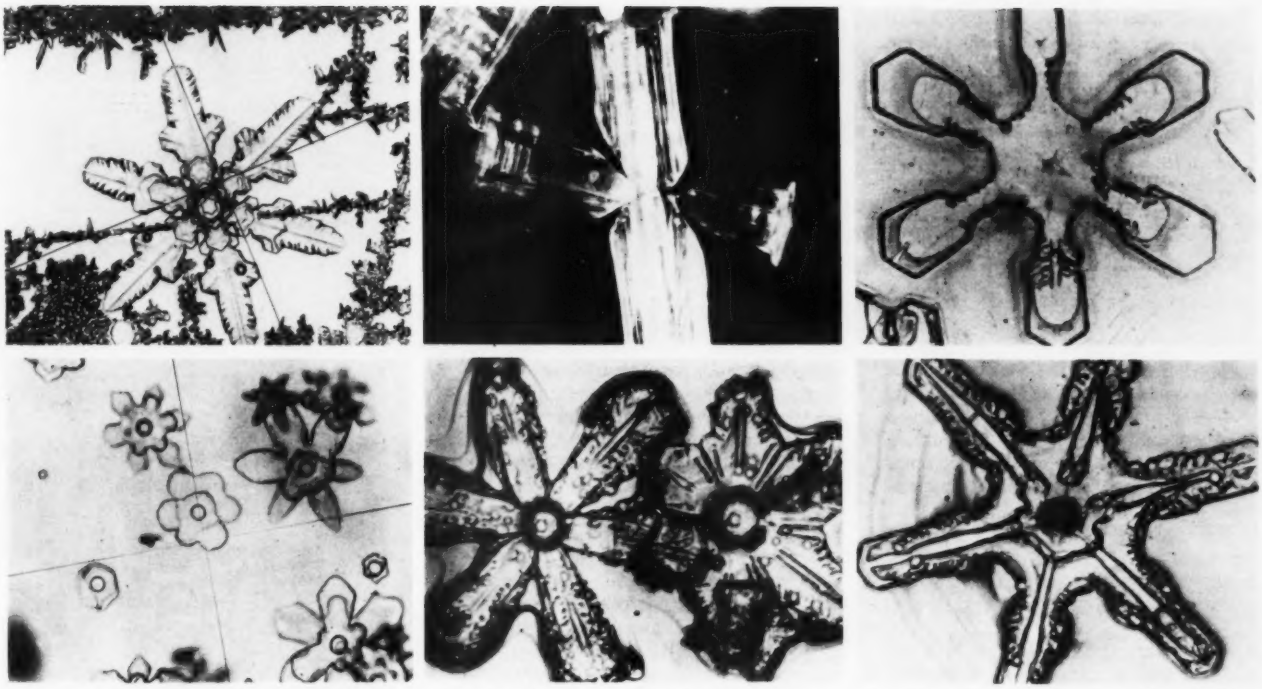
That is in a morning.

What of the longer term, the global scale?

According to Drs. Weickmann and Pueschel, the ever-increasing production rate of



(Top) Paul Allee counts ice nuclei activated on filters received from the western network. (Above, from left): electron micrograph of a natural snow crystal; x-ray spectrum of the elements composing the snow crystal's nucleus; a typical "mixed particle" taken during Sniffer sampling of Denver's polluting "brown cloud;" one section of the particle contains only lead, bromine, and chlorine, and thus is uniquely identified as leadbromochloride.



No two snowflakes are alike. In fact, they are more varied than most people think. Dr. Helmut K. Weickmann, director of NOAA's Atmospheric Physics and Chemistry Laboratory, and a colleague at the State University of New York, Dr. J. E. Jiusto, have studied the different shapes of snow and the weather conditions that produce each. In the laboratory, Dr. Weickmann and Dr. Farn Parungo, a researcher at the Atmospheric Physics and Chemistry Laboratory, one of the Environmental Research Laboratories in Boulder, Colo., created artificial snowfalls to observe how ice crystals take shape. The six-pointed lacy snowflake most people think of as typical (a) is really rare in nature. High-altitude, cold cirrus clouds may produce bundles of bullet-shaped crystals, (b). The flower-like crystal in (c) is actually a double crystal, two flat plates with a frozen droplet in between, formed in supercooled clouds with strong updrafts and large droplets. Sometimes when there is a limited amount of water vapor for building flakes, the two plates of a double crystal compete for water vapor, with half of one plate collecting the vapor on one side while the other plate wins the vapor on the other side. The result is a lopsided crystal like those in (d). When humidity is high, rimed forms (e) occur. A snow crystal becomes "iced up" with extra moisture as frozen droplets form in beads on its outer surfaces. The heart of a snow crystal is the nucleus . . . a tiny particle, such as dust or a silver iodide crystal, around which the supercooled moisture in a cloud freezes. The dark spot in the center of the snowflake in (f) is the nucleus.

manmade aerosols means that in 23 years the number of manmade aerosols in the atmosphere may equal the natural aerosol population. They reached this conclusion after drawing together and analyzing data collected by other investigators on aerosol emissions from various sources and the effects of various amounts of nuclei retained in the atmosphere on global climate. They believe, however, that current efforts at pollution abatement can bring the situation under control before 23 years pass.

The effect a given aerosol will have on climate, they explain, depends largely on how long it remains in the atmosphere. Some aerosols, such as lead from automobile exhausts, are rapidly removed by precipitation. Others may reach the stratosphere and remain suspended there for months or years.

Using information developed from a number of sources and a numerical model devised by Dr. Earl W. Barrett, also of the Atmospheric Physics and Chemistry Laboratory, they calculated the effects on global temperature caused by the screening-out of sunlight by increased atmospheric aerosols. They found that the total amount of aerosols of all kinds make the earth 1.3 degrees Celsius cooler than it would be if the air were aerosol-free. Volcanic dust, which comprises only 0.015 percent of the total aerosol production, has the strongest influence on global temperature because it is thrown upward into the stratosphere, where it has a long residence time. Photochemically produced natural volatile substances, noticed as blue haze in forested regions, make up only about ten percent of total aerosol production, but have a surprisingly large effect—two-tenths of a degree. Man's share of the effect amounts to only about 0.13 degree.

Small values, these, like the tiny particles on which the laboratory's study centers. But perhaps they are the minuscule steps by which a planet's climate may be changed, by which precipitation patterns can be altered by the inadvertent hand of man. To NOAA's students of the nucleation process, the heart of globally large matters hides somewhere in the microscopic forest of a snowflake, or upon the ragged planet of a mote of dust. □

Boulder's Newest Remote Probe

Inside the panel truck, a video monitor shows line of sight track down across the Colorado sky until the dot in mid-screen indicates that the powerful laser is trained on the sandstone face of a Rocky Mountain foothill several kilometers away. This sense of an aimed laser, helped along by the electronic hum and relentless counting of digital time pieces, encourages visions of cliffs going up in a puff of ruby light, worlds at war, and the timely intercessions of rocket-riding heroes in the Buck Rogers mold.

But such fantasies are to be resisted. Although the device being tested in Boulder can be dangerous—one does not look it in the "eye"—and matches one's expectations of what a laser cannon might look like, it is far from a destructive machine. In fact, it is the largest product to emerge from the eminently constructive efforts of the Environmental Research Laboratories' Wave Propagation Laboratory to sense environmental conditions indirectly.

The new remote-sensing system is the offspring of a continuing program in atmospheric spectroscopy—the science of measuring atmospheric phenomena by measuring their efforts on optical and other electromagnetic waves—led by Dr. Vernon E. Derr, deputy director of the Wave Propagation Laboratory.

Lidar, the laser equivalent of radar; is the optical heart of the experimental unit, which also mounts a short-wave radar and infrared radiometer to permit simultaneous measurements over a broad spectral range. This combination of sensing devices, and the unusually versatile lidar's ability to use a wide variety of transmitting lasers, make the system unique.

According to Dr. Derr, the new device should permit serious field tests of lasers and lidar as environmental remote sensors. At the same time, the versatility of the new system will permit laboratory scientists to undertake truly systematic observations of some hard-to-measure atmospheric processes.

"It is widely believed," he says, "that lidar is one of the most promising remote-sensing instruments because it behaves something like a highly sensitized human eye, but with a capability to work in the ultraviolet and the infrared as well as at visual wavelengths. But there is less certainty about how that promise is to be realized in an operational sense. Our present system lets us apply a lidar, using any of several types of laser as the transmitting light source, to see what can be measured this way in both the natural and man-altered atmosphere.

"It will also let us begin scrutinizing things like atmospheric aerosols, water vapor, smog, high-level waves, in real time—that is, as their properties evolve. In many instances it will also give us our first set of baseline data—data against which any future changes must be measured."

The "power" of the system is not easy to express, as it depends on the type of laser used and how well collimated, or aligned, the system's various electromagnetic beams are.

"Clouds and other large scatterers can be probed out to 10 or 20 kilometers," Dr. Derr explains. "Smog and aerosols are measurable out to 5 to 10 kilometers. Where the echo strength is less, our range is less. For water vapor and temperature profiles, for example, our range is about two to four kilometers."

The new apparatus consists of a lidar capable of using any of several lasers—for example, ruby, neodymium, dye, carbon dioxide, nitrogen, and argon lasers—to transmit the probing signal. A 70-centimeter reflector telescope is the lidar receiver, which "sees" the laser "echoes." A microwave scanning the same path as the laser is used to detect aircraft in the vicinity of the laser beam—a safety precaution—and to determine cloud thickness. A television camera shows the operator what the laser is looking at, and an infrared radiometer provides temperature data. These devices are mounted paraxially—that is, nearly along the optical axis of the receiver lens, on a swiveled antenna mount.

"One thing about this system we're especially proud of," Dr. Derr says, "is that it is a precision instrument built mostly out of surplus components. Our telescope mirror came from a balloon-borne spectrometer package. The mount, which gives us

unusually precise control over azimuth and elevation, used to accommodate a NIKE-AJAX radar antenna. So we are beating some swords into plowshares."

Data-acquisition units are housed in a van. The transmitting lasers are housed in a temperature-controlled enclosed trailer, with only the telescope exposed. The transmitting laser pulses are routed through what is called a Coude path in the telescope mount to an output prism—a method which ensures that the light beam is never interrupted by vertical or horizontal rotations of the mount.

The receiving units are coupled to photomultipliers with optical systems and tunable filters, a dual detection system for polarization measurements, and cooled, filtered solid-state infrared detectors. The ability to sense polarization of the laser echoes is another way in which the lidar exceeds the human eye.

Thus far, Dr. Derr and his coworkers in the atmospheric spectroscopy group—Norman Abshire, Richard Cupp, G.T. McNice, M.J. Post, and Robert Calfee—have barely scratched the surface of their new instrument's capabilities.

Last November the transportable system had its shakedown exercise in the Environmental Protection Agency's Denver "Brown Cloud" Experiment, an effort to explain the ochre pall which characterizes Denver's more serious pollution episodes.

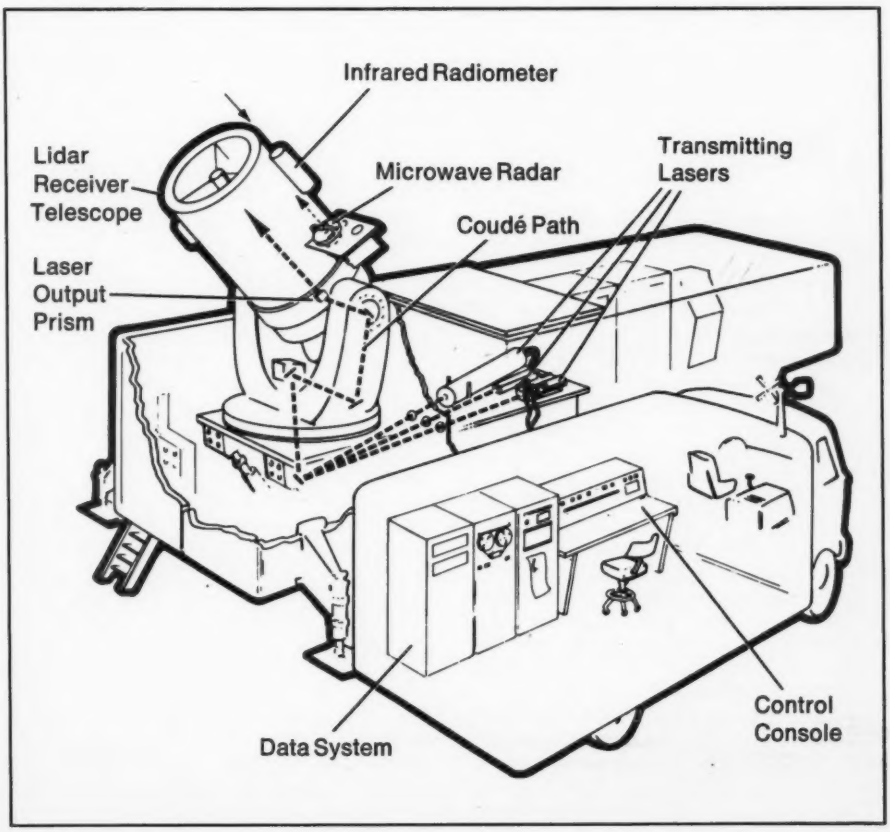
Previous studies have shown that polarized lidar returns may be used to determine whether an observed cloud is water or ice. The NOAA researchers plan to use that information to interrupt data from an infrared radiometer, thus obtaining accurate remote temperature readings of clouds.

"Our coming field season," Dr. Derr says, "will concentrate mainly on cloud-studies—formation and growth of orographic, or mountain effect, clouds, cloud densities, water and ice content and temperatures, and the like.

"Over the longer term, we expect to be studying atmospheric turbulence, analyzing precipitation, probing mountain lee waves, and attempting to relate our data to such things as cloud types, precipitation particle sizes, and other factors."

And it is likely that the new lidar-radar-radiometer remote-sensing system will find an important role in major atmospheric studies now underway around the nation, as it joins the ranks of advanced environmental sensors moving into the field. □

Wave Propagation Laboratory's Dick Cupp adjusts lidar receiver atop trailer van (left). Below, diagram of the laboratory's new remote-sensing system, showing transmitting lasers, microwave radar, and infrared radiometer, all used to sense atmospheric conditions, and television camera that shows system controllers where the laser is pointing.



It's big, busy, and NOAA serves it in many ways.

the other coast

BY JOHN HANNA

Looking at a map of the world or even the United States, one's first impression is that the Great Lakes aren't really all that big; but consider these facts:

- About 300 million tons of waterborne commerce are handled on the system annually.
- More than 64 million persons live and work in the eight Great Lakes States.
- 67% of the nation's steel is produced in the Great Lakes area.
- 42% of all U.S. manufacturing is done in the Lake's basin.
- 48% of all U.S. agriculture is grown near these "vast inland seas" as the Indians described the Great Lakes to Jacques Cartier in 1535.
- 19 States are in the Lakes' tributary area and are served by them.
- The St. Lawrence Seaway, which opened up the Great Lakes to deep-draft ocean cargo vessels, provides a link that extends 2,300 miles to the fields, forests, factories and mines of America's heartland.
- Nearly 40% of the nation's recreational craft are registered in the eight contiguous Great Lakes States.
- There is enough fresh water in the Great Lakes, the largest single supply in the world, to cover the entire continental United States to a depth of nine feet.
- Parallel figures for our neighbor to the north, Canada, are even more impressive, since a larger percentage of its population lives in the Lakes region.

The earliest form of commerce on the lakes was by canoe for inter-tribe trading by the Indians. Next came the French fur traders with their bateaus which were like canoes but much larger. The first full-sized sailing vessel was the GRIFFON (NOAA Magazine—October 1973). She was built above Niagara Falls and was lost on her first voyage. Shipping increased dramatically after the discovery of iron ore and copper near Lake Superior. This led to construction of the first lock at Sault Ste. Marie by the State of Michigan on the site of the former Northwest Fur Company's crude lock built in 1798. It was eventually taken over by the Government and improvements made regularly by the Corps of Engineers. Today's "Soo" locks are world famous. At the time of the State lock construction there were about 250 coal-and wood-fired vessels, including sidewheelers and over 1000 cargo sailboats plying the Lakes. In 1870 the National Weather Service, then called the United States Weather Bureau, was established, just 29 years after the United States Lake Survey, now NOS's Lake Survey Center, had been established to chart these waters. Passenger vessels were very popular in these times, with regular service between many Lakes' harbors. Major navigation construction in the 1820's saw the first Welland Canal built linking Lakes Erie and Ontario, and the Erie Canal constructed providing a water route from New York City via the Hudson River to Buffalo on Lake Erie. All vessels in those days were of wood construction. The first ship made of iron was the MERCHANT built in 1862. Railroad trackage was sparse and shipping, both cargo and passenger, reigned supreme. By the late 1800's, the sailing ship era was on the wane and records for vessel size and tons of cargo carried were being broken nearly every day as new, larger ships were being constructed regularly. Thus, although the actual number of ships was decreasing, the cargo capacity of the Lakes fleet was increasing. It was shortly after this that specially designed vessels began appearing and the first self-unloader was built. As the name implies, the self-unloader dispenses its cargo with no dock unloading facilities required. Bulk cargo carriers were built especially to handle large volumes of iron ore, coal, grain and limestone which is used in steelmaking. Package cargo and automobile-carrying vessels were seen, and tankers designed specifically for carrying petroleum-based products were constructed. The U.S. Lighthouse Service and the U.S. Coast Guard, later to be merged, were extremely active on the Lakes in those formative years.

An event occurred in mid-November of 1913 that very nearly decimated the Great Lakes fleet. Many vessels ignored the square red flag with the black center which fluttered from Weather Service visual warning display stations and were to regret their actions later. The signal meant "storm," and what a storm it was! A southwest gale joined forces with a northwest blow. Lake Huron, where most of the damage occurred, was described as "boiling like a witch's cauldron." Two inches of rain fell at Buffalo in an hour. Rain changed to sleet—sleet to blinding snow. The warning flags which had hung limply in the "calm before the storm" were now straight out from their masts as though starched. Dozens of sturdy, seaworthy "lakers" went down in the holocaust and many others were driven aground by the howling winds and huge waves which were reported to be coming from opposite directions at times. Estimates of damages and the number of lives lost were difficult to obtain because of disrupted communications and because there were so few survivors from the ships lost. Weeks later wreckage and bodies were still drifting ashore. No wonder it is still referred to as the "big storm."

Great Lakes shipping would be severely handicapped if it weren't for a number of NOAA services. Complete weather information, including current conditions and accurate forecasts, are available to the mariner. And they come in a variety of ways. In addition to standard radio and TV broadcasts, and newspaper reporting, as sent over standard NOAA weather wires, coastal warning display stations are maintained and special marine weather forecasts can be obtained from a number of sources. National Weather Service forecasts are retransmitted by U.S. Coast Guard UHF and VHF radio stations. NWS also broadcasts continuous weather information from seven of its stations strategically located around the Lakes. Three major NWS forecast offices located at Chicago, Detroit and Cleveland are responsible for keeping the mariner informed of current and expected weather situations. Many commercial vessels tune in to NWS's MAFOR broadcasts. MAFOR is short for "marine forecast." The system, which is coded, gives the vessel's captain critical data on wind direction, wind speed, forecasted weather and expected wave heights after first giving the date, forecast period, name of the lake or waterway and related identifying information. MAFOR broadcasts are made by six marine radiotelephone stations positioned at key sites. Marine Weather Service charts are also published by NOAA to aid the Lakes' navigators. There are two for the Great Lakes. One covers Lakes Huron, Erie and Ontario, and

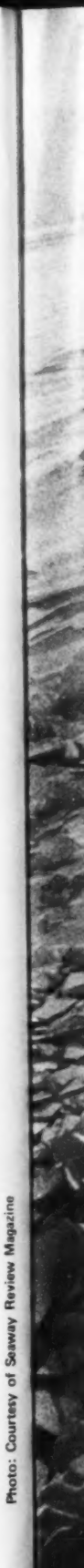


Photo: Courtesy of Seaway Review Magazine

Winter on the Great Lakes brings scenes of pristine beauty but the frozen waters shut down commerce completely for three months each year.

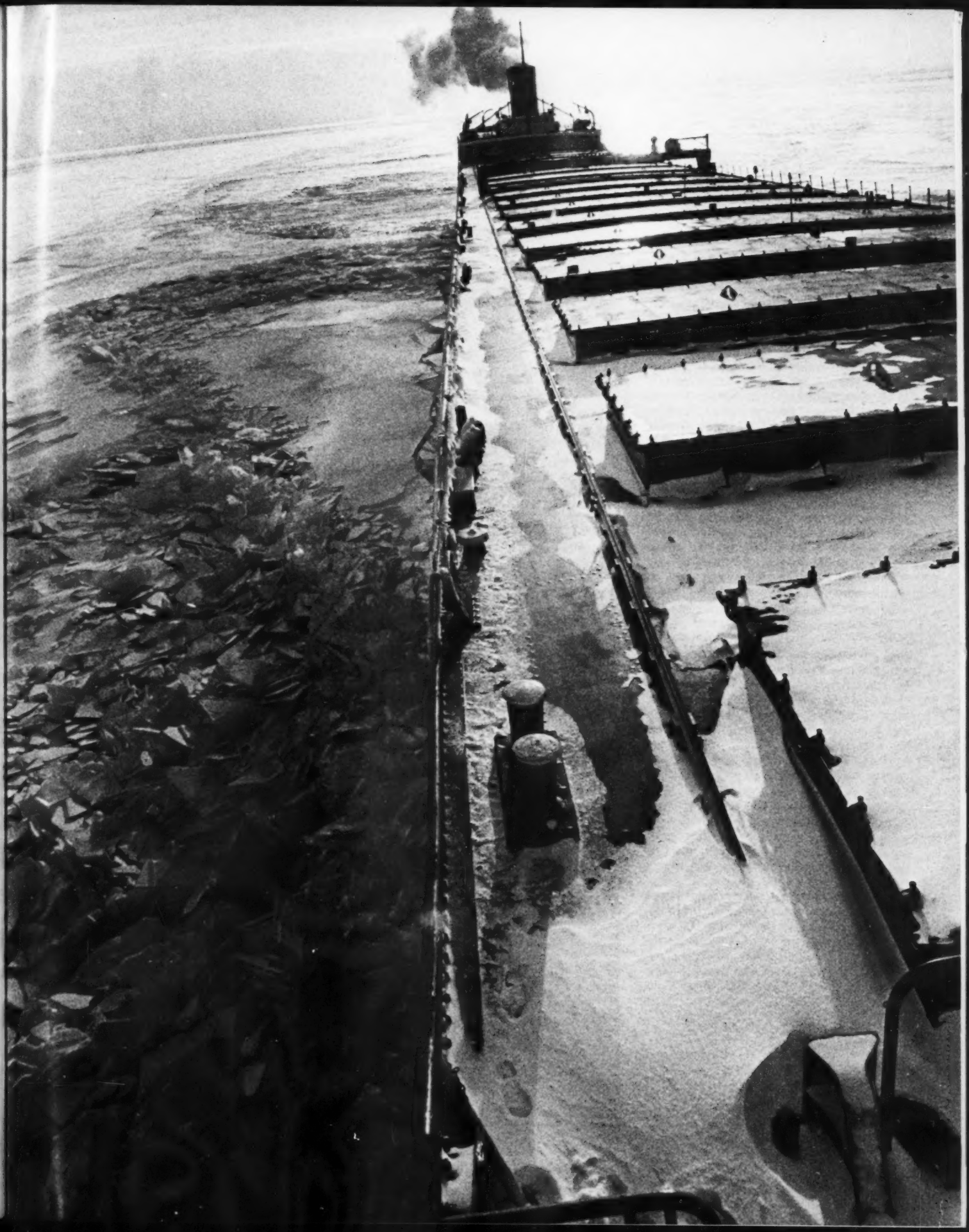


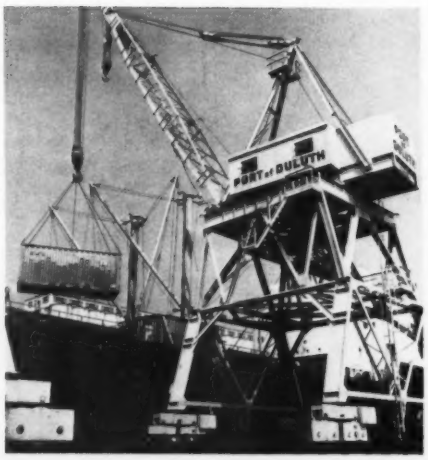
Photo: Courtesy of Seaway Review Magazine

the other Lakes Michigan and Superior. Each lists radio broadcast stations that carry marine weather information, their schedules and locations of their antennas. The location of storm warning displays, as well as the locations and phone numbers of National Weather Service stations, are also shown.

NOAA's National Ocean Survey, through its Lake Survey Center in Detroit, furnishes accurate, up-to-date Great Lakes nautical charts so essential to the safe navigation of these, sometimes, turbulent waters. There are about 150 different ones all told and they come in four different types. Small-scale, general charts are usually used for planning purposes or open-lake navigation; medium-scale coastal charts for offshore sailing; large-scale, which are highly detailed depiction of the Lakes many harbors; and fourth, two types specifically designed for the pleasure craft operator, which come in either folded or booklet styled versions.

The Great Lakes Pilot, similar to the National Ocean Survey's coast pilots, has over 600 pages and contains navigational information about the system which cannot be conveniently shown on the charts. Included are detailed shoreline descriptions, bridge and lock opening signals, Federal and local rules and regulations, and listings showing U.S. Coast Guard stations and National Weather Service coastal warning display stations, which are also shown on the charts.

Another important NOAA service is the furnishing of Great Lakes water level information. The levels of the lakes fluctuate on an annual basis, that is, high in summer and low in winter. Their levels also change from year to year depending on hydrological factors and other parameters, including basin condition, rates of inflow and outflow and evaporation. To the commercial shippers, NOAA data on lake levels permit the maximum allowable loading of vessels, and forecasts of levels encourage advance planning of cargoes, volumes and routes. Lake level data are obtained from a network of



Prepackaged cargo is lifted from a container ship at Duluth on Lake Superior (left). Queen of the Great Lakes is the 1,000-foot-long Stewart J. Cort (right). The opening of Eisenhower Lock on the St. Lawrence Seaway in 1959 brought worldwide commerce to the Great Lakes.

Photos: Courtesy of Seaway Review Magazine

over 50 measuring stations situated around the Great Lakes. After refinement, the information is issued to all interested persons. The most popular item is a Monthly Bulletin of Lake Levels which shows current and projected levels, long-term averages and highs and lows of record, and related data. It is presently sent to over 7,000 recipients every month.

Great Lakes commerce falls into two general categories, bulk and general cargo. Except for iron ore from the rich Labrador fields, which is shipped up the St. Lawrence River to Lakes' steel mills in modest quantities, and overseas bound grain, most bulk commerce is interlake, that is, it is shipped from lake ports to lake ports. Bulk cargoes account for the largest share of Great Lakes tonnage figures. Iron ore, averaging 100 million tons annually is far and away the largest single commodity shipped, with coal, grain, limestone and cement following. Until the taconite process of pelletizing and refining low grade ore was discovered a few years ago, it appeared that, with the upper lakes rich supply of natural high grade ore running out, alternate sources would have to be found. These included a rich field in Venezuela and Canada's huge Labrador range. Pelletizing not only makes ore shipping more efficient by providing a higher grade product with less waste but also improves blast furnace and open-hearth steel producing quality and efficiency. Other low grade U.S. ore deposits are located in the east central portion of the country and could be pelletized if northern Lakes sources should become depleted.

Grain traffic has increased rapidly in the past few years. Major grains include wheat, corn, rye, soybeans and oats. While it has always been one of the major bulk commodities on the Lakes, the recent $135 million sale of United States grain to Russia has caused shipments to increase dramatically. Direct overseas shipments have gained modestly but traffic to eastern grain elevators for transshipment to foreign countries rose from 28.8 million bushels through August of 1972 to 107.3 million through August of 1973. Total grain shipments in 1972 amounted to over 965 million bushels. Russian ships, relatively new to the Great Lakes-St. Lawrence Seaway, frequently bring general cargo in and haul grain out. One Russian Captain quoted in SEAWAY REVIEW said of the system, "it can be ranked among the best in the world in technical and navigational equipment and in traffic organization, communication and control."

Bituminous coal from areas south and east of the Great Lakes is instrumental in achieving economies in the transportation of bulk cargoes. Vessels which bring iron ore and limestone down from the upper Lakes region load coal from lower lakes ports for their return trip, thus providing full cargoes both directions. Coal traffic has been one of the steadiest commodities handled, averaging about 40 million tons annually. The principal users of coal are the electric generating plants. Because of concern over air pollution, some companies are switching from conventional bituminous coal to a low-sulphur type which comes from the western United States. According to the Great Lakes Commission's GREAT LAKES NEWS LETTER, a new coal-handling facility is being constructed at Superior, Wisconsin. That port is located at the extreme western end of Lake Superior. The low-sulphur coal would be received via rail and transshipped in deep-draft vessels for delivery to lower lakes electric plants. One company is expected to receive about 500,000 tons this year from the new coal-shipping docks at Superior.

Limestone is an essential ingredient used in the making of steel. Major sources of limestone are located in northern Lake Huron. The self-unloader type vessel is usually used in this trade, with deliveries made to steel mills on the Detroit River, Lake Erie and lower Lake Michigan. Limestone shipments average about 35 million tons annually.

Other bulk items handled on the Lakes include cement, petroleum products, other agriculture products such as Michigan beans, chemicals, scrap iron and sand.

Principal Great Lakes harbors usually fall into one of two categories; either they are major shippers or major receivers. Examples would include Toledo, Ohio, where over 30 million tons of coal are shipped annually; Two Harbors, Minnesota with about 5 million tons of iron ore shipped; Duluth, Minnesota shipping about 40 million tons annually; Chicago, Illinois with total annual receipts of 50 million tons; the Port of Detroit, almost 30 million tons received; and Cleveland, Ohio, which receives around 23 million tons annually. Harbors like Two Harbors and Thunder Bay, Ontario (grain) deal almost exclusively with a single product, whereas other ports handle a wide range of products as well as large volumes of certain cargoes. Other major harbors include Toronto, Hamilton and Windsor, Ontario, and Milwaukee, Wisconsin.

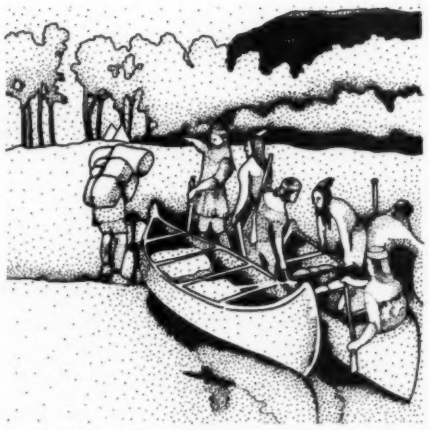
It is of interest to note that nearly all U.S. harbors on the Great Lakes have been improved and are maintained by the Army's Corps of Engineers. This agency plus NOAA's units, the U.S. Coast Guard, U.S. Customs and other Federal agencies, work closely with each other to serve Great Lakes navigation.

As noted earlier, the number of vessels on the Great Lakes is decreasing but the total capacity is increasing. One of the reasons for this is construction of new ships like the STEWART J. CORT, reigning queen of the Lakes fleet. Rivaling many of her ocean-going sisters, the CORT is 1,000 feet long, 105 feet wide and can carry over 58,000 tons of iron ore pellets. Construction of the new Poe lock at the "Soo Locks" by the Army Engineers is partly responsible

for stimulating the business of shipbuilding. The new lock, largest in the world, is 1,200 feet long, 110 feet wide, with 32 feet over the sills. On her first trip the CORT doubled the previous record for a single cargo of iron ore by carrying almost 56,000 tons. Two new 1,000-footers have been ordered. All recent vessels constructed are of the self unloader type and have rated unloading capacities of between 5,000 and 7,000 tons per hour. A number of vessels have gone through a "lengthening" process. This is done by cutting the ship in half, inserting a "mid-body" and then welding her back together again. Thus cargo capacity is increased at a fraction of the cost required to build a brand new vessel.

The opening of the St. Lawrence Seaway caused dramatic changes in the Lakes shipping picture. For the first time, full-sized ocean-going cargo vessels could climb the 600-foot stairway from the salty Atlantic to the cold, clear fresh water of Lake Superior. And they did! Seasoned vessel watchers were stunned by these "funny-looking" fellows with their superstructures amidships and all those cargo loading and unloading booms sticking up both fore and aft. At that moment in time the Great Lakes truly became international and had earned the right to be called America's Fourth Seacoast. At first ocean ships visited more out of curiosity than anything else, and complacent port operators sat back and awaited the avalanche of overseas business they felt would soon be knocking at their doors. They didn't realize that their cargo handling methods and storage facilities, for years aimed at bulk cargo traffic, were woefully inadequate for this new type commerce. It didn't take the progressive ones long to figure out why foreign flag carriers would call a few times and then not visit again. Cargo handling equipment and procedures were improved and modernized, construction of specialized storage and docking facilities were started and special commissions and foreign offices were set up to go after the lucrative, high-value general cargo business. Chicago is a good example. Richard B. Ogilvie, Governor of Illinois, as quoted in SEAWAY REVIEW said,"—overseas commerce through the seaport of Chicago annually contributes $200 million to the economy of Illinois and accounts for the employment of more than 20,000 of our citizens—." But success was awhile coming. In the early days of the Seaway, the St. Lawrence Seaway Development Corporation, the Federal agency set to administer the U. S. section, pushed, prodded and pleaded for the type and class of facilities that were essential if the Seaway was to contribute what was expected of it. The hard work and devotion had paid off for the St. Lawrence Seaway Development Corporation. The last three years have seen 50 million plus tons of cargo and the Seaway's future seems assured.

The future of Great Lakes-St. Lawrence commerce appears to be solid, with all projections and forecasts predicting steady growth. There are a few dark clouds and a few bright ones too, coming up in the years ahead. One study has shown that the Welland Canal will reach its maximum capacity in 1990. Therefore, it will eventually be necessary to expand it or construct a parallel waterway, possibly in the U.S., to compliment rather than compete with the Welland. A Corps of Engineers' study has shown that such a canal is feasible. Another possible retardant is the necessity to shut the whole system down for about three months each year because of severe ice problems (NOAA Magazine Jan. 1974). Considerable time, energy and money are being expended by a number of Federal agencies, including two from NOAA, in an attempt to first, extend the season, and then someday possibly to provide year-round navigation. Defeating the elements is a significant challenge and when combined with resistance from the traditionalists who,



by habit, expect and look forward to the annual winter close-down, offers a truly monumental task. On the bright side is a new magic word called "containerization." Great Lakes port operators have been quick to recognize the potential value of such a system. What it does essentially is to package small, difficult-to-handle or high-theft potential items in large containers of box car size. High-damage, susceptible cargoes could be included and the point should be made that containerized items need not necessarily be small. A feeder system for containerized cargo is being studied. Under it, transportable material would be collected from a variety of sources, deposited in a central receiving-pick-up area, and then loaded aboard special containerization cargo ships. Such a system could also work in reverse.

The fourth seacoast has not received excessive amounts of publicity or support, particularly from certain areas (the railroads and coastal port interests). However, it appears that the first plateau has been reached in the quest for international recognition, as well as in a fair share of Lakes-bound and Lakes-originated commerce. □

ACKNOWLEDGEMENTS

Sources used in preparation include Seaway Review magazine, Great Lakes Commission News Letter, Lake Carriers Assn. Annual Report, and Waterborne Commerce Statistics compiled by the U. S. Army Corps of Engineers.

A simple swap of trade goods for fur pelts (left) characterized early Great Lakes' commerce. Flags aflutter, an excursion boat of another era plies Lake Erie (below). Today, the Lakes are joined by complex locks and canals (bottom).

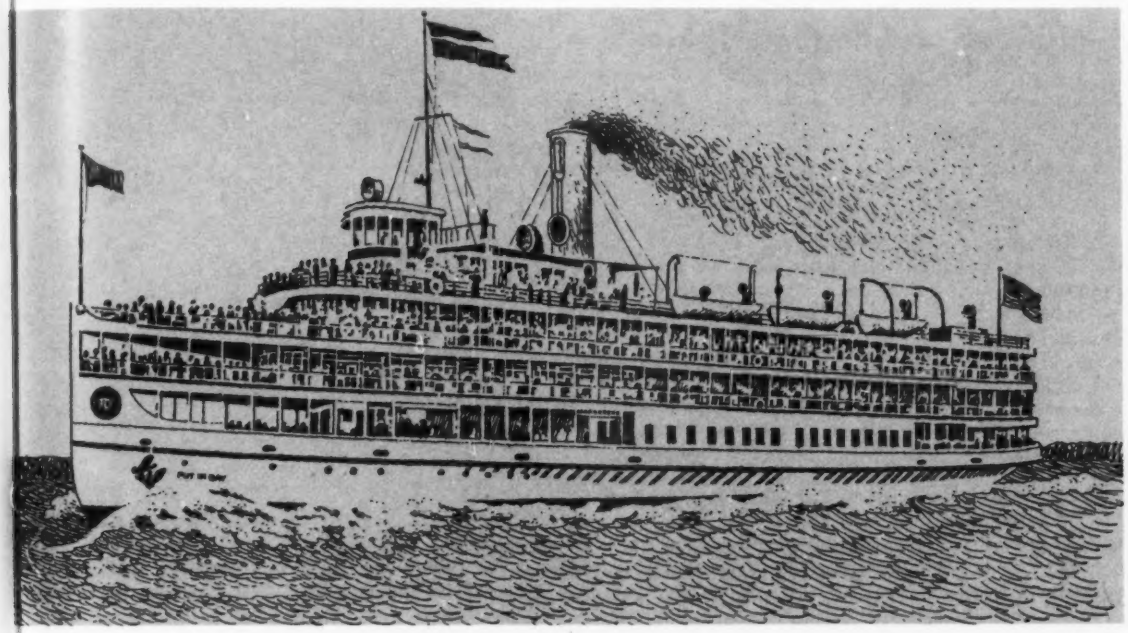


Photo: Courtesy of Seaway Review Magazine

noaa's new limno link

In the new Great Lakes Environmental Research Laboratory, NOAA Lake Researchers Join Forces in Efforts to Understand, Manage and Preserve These Vital Bodies of Water.

BY LOUISE A. PURRETT

This summer, NOAA puts all its Great Lakes researchers into one laboratory. Scientists from the Lake Survey Center in Detroit are joining researchers working on the International Field Year for the Great Lakes (IFYGL) in a new NOAA laboratory at Ann Arbor, Michigan. The Great Lakes laboratory, established April 28, is the newest partner in NOAA's Environmental Research Laboratories.

At the Great Lakes Environmental Research Laboratory, some 30 scientists will investigate the total lake ecology, from the sediments below the water to the air above. Dr. Eugene J. Aubert, IFYGL Project Office Director, heads the new laboratory.

IFYGL will be the main item on the GLERL agenda for the first few years, and, says Dr. Aubert, "will help tie the whole thing together." The project is an ambitious joint effort between the United States and Canada to collect, analyze, and manage massive amounts of data on one of the lakes the two nations share—Lake Ontario. NOAA is the lead United States agency for the project. Beginning in April 1972, some 600 United States and Canadian scientists and technicians spent a year collecting reams of data about Lake Ontario. But that was just the beginning of the six-phase project. The job of analyzing the data will occupy the scientists until 1977. In addition to the scientists from the IFYGL Project Office in Rockville, about a third of the scientists from the Lake Survey Center are engaged in IFYGL work. Dr. Aubert estimates that for the next couple of years, two-thirds to three-fourths of the GLERL efforts will be occupied with IFYGL.

In the longer view, NOAA has mapped out some of the projects and goals of the Great Lakes Lab. The research will have two emphases. Basic research will contribute to the background of general knowledge about the lakes. Other projects are problem-oriented, aimed at solving specific problems or meeting specific needs, such as improving navigation, preventing erosion or pollution, or predicting changes in lake water levels.

One of the main goals of the lake lab will be a comprehensive model of lake circulation—how the water circulates in response to the natural forces upon it. Existing models are in early stages of development, dealing with the effects of surface wind stress and surface heat flux. The GLERL scientists are developing a hierarchy of models that includes every conceivable facet and factor, such as wind stress, differential heating and cooling, inflow of water from tributaries, seasons, and the shape of the lake.

Some of the Great Lakes harbors are plagued with unpredictable currents that call for tricky navigation. Toledo Harbor, which has particularly troublesome currents in its entrance channel, is already under study. The researchers hope to produce a device that will show the direction and speed of these currents at any given time.

The group will also study the most familiar type of water motion—waves. Wave action may erode the shoreline in one place and build it up somewhere else. Data on waves can be used to predict wave-induced changes in the shoreline. Surface waves are a hazard to navigation—especially for recreational boating. Wave data must also be considered in designing ships and shoreline structures. Present wave theories are based largely on observations from the oceans. where waves may travel great distances without obstruction. The situation on the lakes is quite different: the total distance from end to end is much more limited and a variety of obstacles may impinge on a wave's path, all making wave predictions much more difficult. The researchers are developing models to predict wave conditions from the meteorological conditions and lake geometry.

The lakes are also subject to seiches—fluctuations in water level that result when water at one end of the lake rises as the other drops, like liquid sloshing back and forth in a bowl. Seiches may cause considerable flood damage to shoreline property. When more is known about water motion in the lakes, perhaps potentially destructive

Niagara Falls pours water from Lake Erie into Lake Ontario. Water flow in and out of lake systems will be scrutinized in studies of lake circulations.

seiches could be better predicted.

Another major project will be to develop comprehensive models of lake ecology. These models would consider the dynamics of such componetns as phosphorus, phytoplankton, zooplankton, nitrogen, and oxygen, and describe the variations in time and space of physical, chemical, and biological properties—the primary colors in the lake ecology picture—and how these properties contrast and mingle. Information on the characteristics of the water, the nutrients, sediments, and life forms and how these all interact will be combined with data on lake diffusion to assess the natural processes and the effects of contaminants.

Lake levels may change drastically over short periods of time, rising or falling several feet in a few hours, due to wind setup. Long period lake level variations also occur over seasons and over periods of years Studies of lake levels, lake hydrology and how water is added or subtracted by the network of rivers enmeshing the lakes will aid efforts at water quality control, power generation, flood control, navigation. The NOAA scientists hope ultimately to improve prediction of changes in lake levels and river flows. Winter ice impinges on navigation and shore facilities, and determines

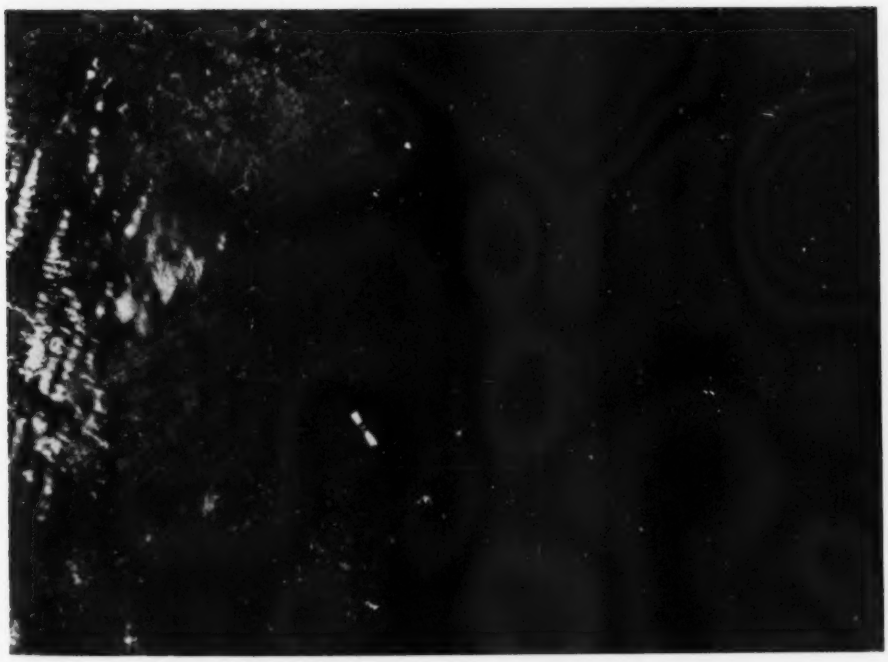
A wall of sandbags provides a temporary defense against the many forces—waves, seiches, high water levels—that may flood lakeshores. GLERL scientists hope to learn to predict and control such changes.

the length of the shipping season. With an eye to eventual improved prediction of ice conditions, GLERL scientists will look at how ice forms, its thickness and extent, where it moves, and when it melts.

Complex interactions between lake, atmosphere and land produce a variety of phenomena—localized heavy snowfalls, seiches, dense fogs—all greatly affecting human activity. The GLERL scientists will attempt to develop improved techniques that the Weaher Service can use to forecast potential hazards.

The rapidly growing population surrounding the Great Lakes will need new sources of power. Power plants should be built at minimum environmental cost. NOAA scientists will develop tools to examine environmental effects associated with the entire problem of planning future power plants: selecting sites, cooling methods, and fuels.

The Detroit waterfront, part of a major trade route that has made seaports out of midcontinent cities. Some GLERL projects are aimed at improving navigation and extending the shipping season.



Cameras on NASA's Skylab space station provide unique overviews of the 25-mile long Detroit River, a link in the watery chain that connects Lake Huron and Lake Erie.

In recent years, pollution of public beaches has been a serious problem. Many beaches are forced to close during the summer because high bacterial levels make the water unhealthy for swimmers. One GLERL project will develop environmental science tools to predict the extent and concentration of this pollution, trace it to its source and suggest ways to control the sources so beaches will suffer less.

Other studies will focus on lake climatology, the population dynamics of key organisms, and water quality in the various bays, rivers, and harbors.

To accomplish these goals, the scientists will work in lab and lake. The facilities at Ann Arbor include laboratories for water chemistry and sediment studies, an ice laboratory with a storage room kept at –30 degrees Celsius for close-up looks at ice, and a biology laboratory for analysis of samples collected in the field and for observing the effects of environmental changes on selected species. A lakeside facility will provide a starting point for field research. For research on the waters of the lakes, the limnologists will use NOAA's 65-foot research vessel, SHENEHON, operated by the National Ocean Survey's Lake Survey Center.

The laboratory site at Ann Arbor was selected for its central locaion and for its proximity to the University of Michigan, explains Dr. Aubert. The University of Michigan is a Sea Grant institution, with an ambitious program of lake research and marine applications. The NOAA lake researchers hope to work in conjunction with their colleagues at the university.

In the more distant future, the GLERL may become part of a NOAA Great Lakes Center, which would include regional offices of the National Ocean Survey, the National Weather Service, the Environmental Data Service, and other agencies—all with a Great Lakes focus.

More than 35 million people in the United States and Canada live within the field of influence of the Great Lakes. Major industrial centers line their shores. The lakes serve as playgrounds, water sources, coolant or motive force for power plants, and major routes for trade and transportation. But the many uses of the lakes are also creating some of their problems. If the lakes are to be both exploited and preserved, they must be skillfully managed, and the necessary skill can come only from a more complete understanding of the lakes. The NOAA Great Lakes scientists, from their new laboratory in Ann Arbor, hope to provide that knowledge. □

National Ocean Survey Celebrates Bicentennial With

COPPERPLATE ENGRAVING'S LAST HURRAH

BY WILLIAM A. STANLEY

In a small room in a suburban community not far from the hectic pace of the nation's capital, a government printer is bringing to a close a romantic period in American life dating back to the early years of the Republic.

There, in Riverdale, Md., in a government facility Matthew R. Lilly painstakingly reproduces nautical charts from old copperplate engravings, an art which had its beginnings in the United States in the 1830s.

Lilly is printing on a 123-year-old press a large number of 19th century charts in connection with the nation's bicentennial celebration. When the program is completed, early in 1976, it will mean the end of an era. Due to the age and condition of the copperplate engravings, which are kept in a guarded vault for safekeeping, few prints will be reproduced again from these relics of a bygone age.

Copperplate engraving, which once flourished in the United States, has been replaced by photo-lithography. Except for Lilly's work, there may be no largescale reproduction from copperplate engravings anywhere in the United States.

During its heyday, from the late 1850s until about 1916, it reached a height of artistry in the United States perhaps unexcelled in the world. Its practitioners were skilled artists and the products they turned out were works of art which are today much sought-after treasures. One of the copperplate engravers later went on to become one of America's most famous artists. He was James McNeill Whistler, whose portrait of his mother is known to millions.

Lilly reproduces the old charts through a series of processes that otherwise vanished from map reproduction a half century ago. He is the last of a long line of illustrious predecessors. Zander Ingram, the man who preceded him, contributed his share to the operation with more than 32 years of service and Thomas J. McGrath, the last of the great copperplate engravers, witnessed the transition to present day lithography. Copperplate engravings were gradually discontinued by the federal government after 1916 and phased out completely by 1926.

The copperplate engravers were employed by the Coast and Geodetic Survey, the nation's first federal chart maker, whose origin dated back to 1807. The agency was succeeded in 1970 by NOAA's National Ocean Survey. The work of these engravers was perhaps the most artistic form of reproduction used during the 19th century.

Engraving is primarily the art of drawing on metal, or other substance, by means of incised lines. The term "engraving" was first applied only to work produced on metal, but later included the impressions reproduced on paper. Copper was selected for engraving due to its comparative softness.

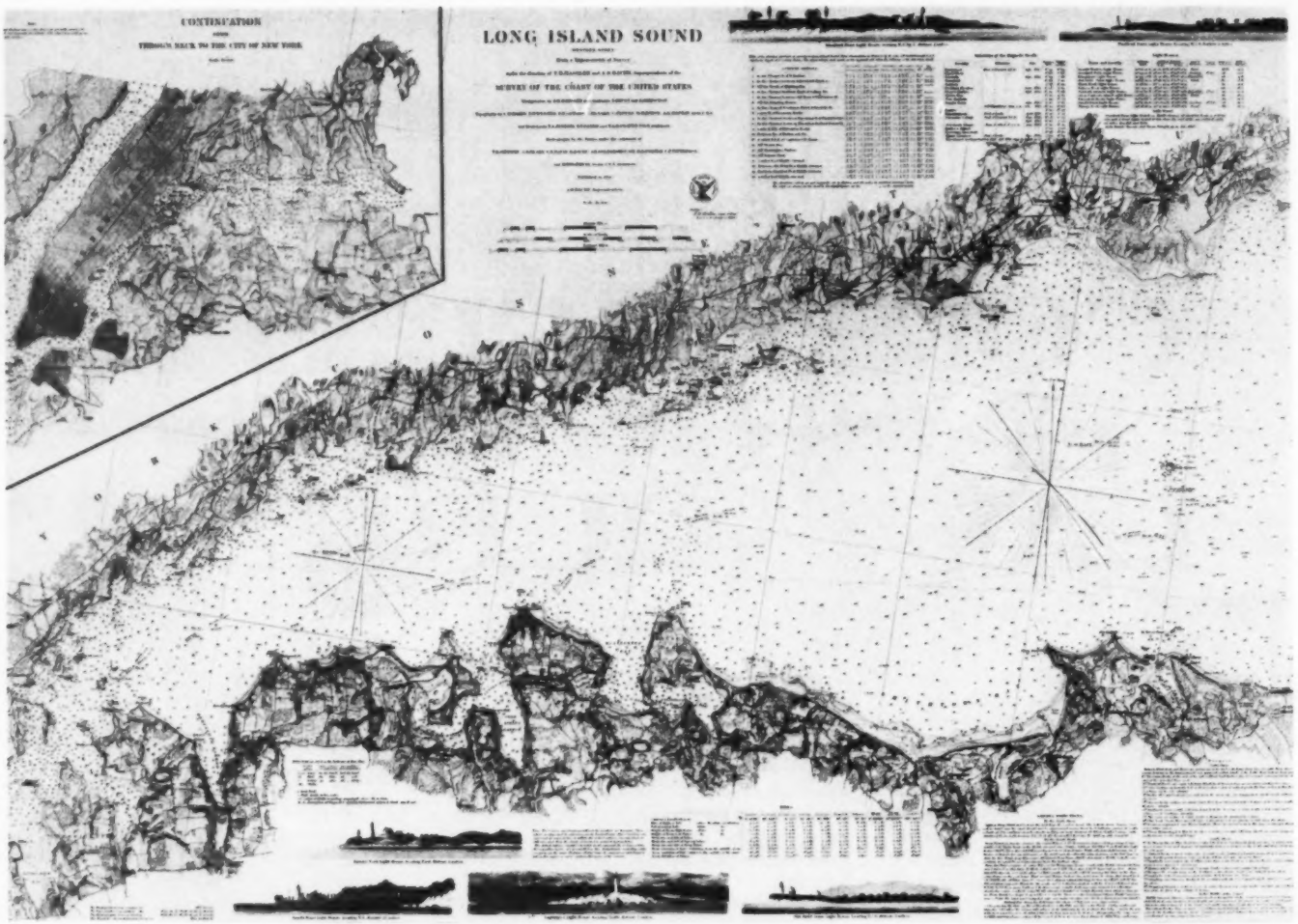
Lilly operates a flat-bed, single roller Stockman Printing Press purchased in 1851. Located with the press on a small catwalk which surrounds the printing area are tools and various other equipment which form the memorabilia of mid-19th century printing.

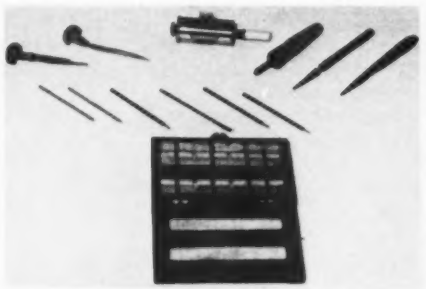
A hot plate originally designed for coal and later electrified allows the printer to heat and remove the wax coating that covers each of some 600 copperplates still remaining in the archives of the Survey. Once the wax is removed the plate is carefully examined for small particles embedded in the minutely engraved lines. Using a magnifying glass and employing delicate engraving tools, Lilly clears and makes more pronounced the engraved lines worn by time.

A "wet table," slightly elevated to permit runoff, allows sheets of heavy chart paper to be laid, moistened by a sponge and rubbed briskly with a small brush. This unusual preparation of the paper allows the printing ink to be absorbed more readily, affording a clearly definable image. After each sheet of paper is scrubbed it is positioned between two pieces of blotter and permitted time to achieve the right consistency of moisture before the paper is applied to the plate.

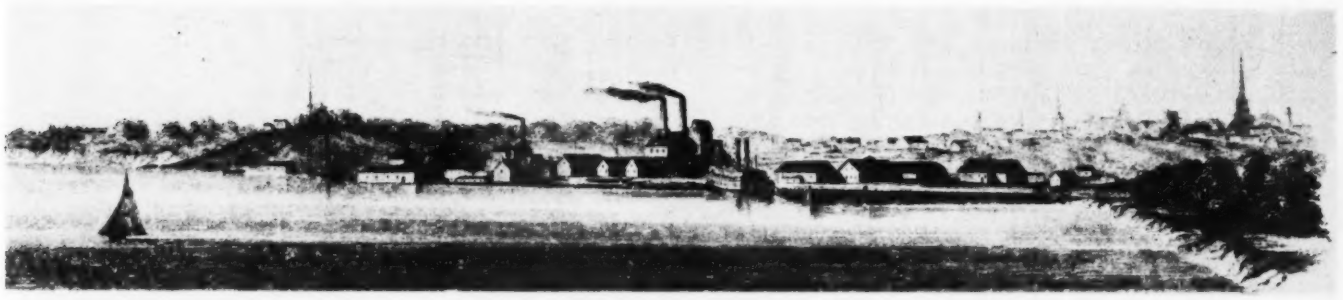
Meanwhile the plate itself is hand inked by a large ink roller followed by a hand massage using a circular motion with the palm of the hand and pumice to remove only the excess ink left in areas not to be printed. The moistened paper is then laid

For the nation's bicentennial, Matthew Lilly is reproducing nautical charts from old copperplate engravings, using a 123-year-old press.





The lines of copperplate engravings of early nautical charts, such as the 1855 chart of Long Island Sound (top), are cleaned and made more pronounced (right) with delicate engraving tools (above).



View of Hudson City, from near the Light House

over the face of the plate in preparation of the actual press run. The press itself, originally designed as a hand cranked operation, was modified at the turn of the century to include a 1½ ton motor which moves the flat-bed back and forth.

The copperplate is brought into position on the flat-bed press and is rolled between the press bed and a large roller attached to the ceiling which is covered with lambskin so as to protect the soft copper as it passes. This entire process of inking, paper preparation, and press run must be repeated for each print, including the complete reinking by hand of the plate istelf.

Although engravers finally settled on copper as the best metal for their purpose, various other methods were tested before that, some with fair success. From earliest times of charting when Gerhard Kremer, better known as Mercator, published his nautical projection to portray a map of the world in 1569, there has been an ever-expanding and accellerated interest in reproduction techniques. Prior to the period of Mercator, maps had been reproduced in the "Rudimentum Novitiarum," published in 1475 from woodcuts. Other maps, reproduced from copper engravings, had appeared in the first two editions of Ptolemy's "Geographical Guide," an atlas published in Italy in 1472. They were not only the first to be published in print, but also are among the oldest known speciments of copperplate engraving.

The Atlas of Ptolemy, in various editions, with new and corrected information, was the most popular form of geographical knowledge for a hundred years. Wood engraving kept pace for a considerable time especially in Germany, but copper in the end surpassed it as an effective means of reproduction.

Other processes were devised during this period, including printing from a polished calcareous stone, the basis of lithography, which was invented by Aloys Senefelder (1771–1834), a native of Prague, Czechoslovakia. It was in 1796 that Senefelder discovered, near Munich, a limestone formation which possessed an equal affinity for grease and water. Senefelder took long walks and one day, while sitting by a stream, happened to draw some designs on several stones with crayon. The idea then occurred to him to try to set an impression on paper by covering the characters with grease blackened with lampblack. It worked so well that Senefelder, being anxious to discover some inexpensive method of printing, perfected the process for commercial use.

It became evident in the field of cartography, however, that copperplate engraving was destined to become the most expeditious manner by which the cartographic skills of the map maker could be accurately transferred and reproduced into a meaningful likeness of the original compilation. The Coast Survey utilized this technique in its early attempts at chart reproduction.

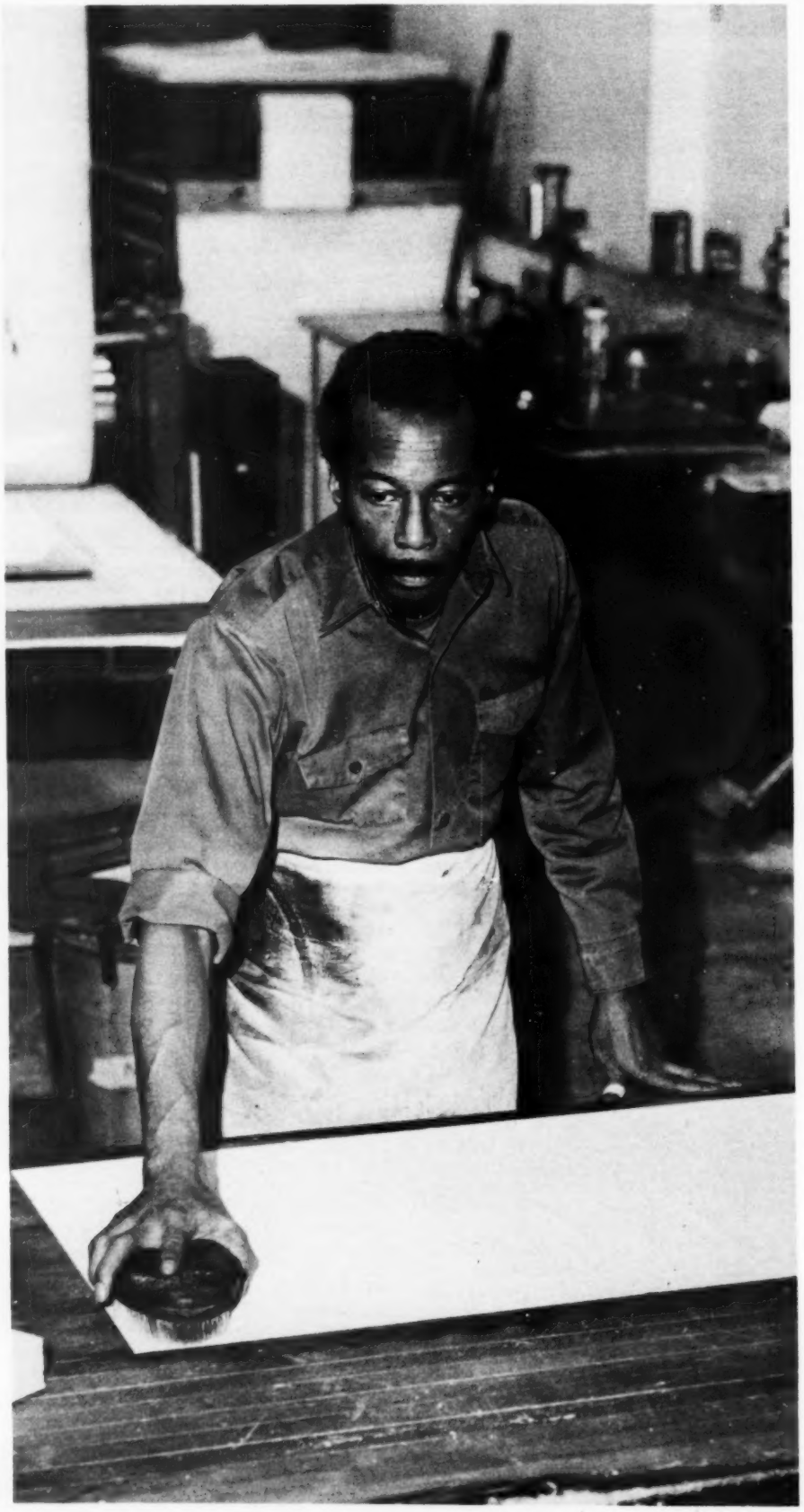
Copperplate engravers employed unique tools to achieve their artistic pursuits of illustrating on metal an accurate likeness of the original document. The first engraved charts of the Coast Survey were at a scale of 1:10,000 of Bridgeport, Connecticut, in 1835; New Haven, Connecticut, 1838; and Newark Bay, New Jersey, 1839. These first renderings probably were produced commercially and it is probable that Congress had the engravings made in support of some administrative requirements needing numerous reproductions of the same item.

The Newark Bay chart is of particular interest in that during a Congressional investigation of the Coast Survey in 1842 this chart was advanced as a reason why Ferdinand R. Hassler, the first Superintendent of the Coast Survey, was not competent as such and should be replaced. It seemed that an error had been made in the scale of the Newark Bay chart and it had been so published. However, the findings of the committee were inconclusive and Hassler was exonerated of all charges.

The art of copper engraving began to flourish in this country in the mid-19th Century, which led to a decade of "workshops" in America. Hassler immediately recognized the advantages of copperplate reproduction as an expeditious means of gaining interest for Coast Survey products at a time when the young agency was in need of establishing its professional standing. Prior to the Coast Survey, no maps or charts had been published in the United States which included detailed hydrography; therefore no engravers were available in the country competent to do this type of work.

Hassler, eager to begin production, found little hope that America's young engravers could achieve the refinement he required. Late in 1842, he imported two engravers from Europe. In May 1843, an apprentice engraver from Philadelphia was employed and the young man was launched on his career in the newly formed engraving unit.

The engravers began work on a 1:80,000 scale chart of New York Bay & Harbor and another chart in six sheets covering the same area at a scale of 1:30,000. Professor Hassler intended that the imported



(Top) Matthew Lilly removes one of 600 copperplate engravings kept in a guarded vault. After the protective wax coating is removed and the engraved lines are cleaned, the plate is hand-inked (above). Heavy chart paper is moistened and rubbed with a brush (right), so that the printing ink will be absorbed more readily.

engravers should train the American apprentices. Due, however, to the lack of success in the training program, as late as 1854 first-class engravers were still being imported from Europe. So badly needed were the engravers that it was necessary to detail a Coast Survey employee to special duty in Europe to recruit additional master engravers.

As time progressed, refinement of copper engraving techniques improved. By the late 1850's engraving in the Coast Survey had begun in earnest. The Engraving Division was organized, headed by Lt. J. C. Clark, USA, (on assignment from the Army) with clerical assistants, seven engravers and a number of apprentice engravers in various stages of training. The American apprentices included Messrs. Siebert, Rolle, Dankworth, Knight, McCoy and Whistler.

Whistler was a native of Lowell, Massachusetts, and was hired at the insistence of Senator Jefferson Davis of Mississippi, who felt the young man's talent would be put to better use than at the Baltimore locomotive yard where he was employed. As an apprentice, however, his worth was not recognized by his supervisors. After only three months (November 7, 1854 to February 12, 1855) he was dismissed for lack of attendance.

Gradually, copperplate engraving of the Survey was transformed from a disoriented beginning to a highly trained body of professionals. Those early members of the Engraving Division also worked out a system for each step in the copperplate printing process. As the cartographers completed their detailed hydrographic compilations the drawings were forwarded to the "engraving rooms." The first step was to select a piece of copper for the engraving. The "electrotype room" was where the blank copper was stored. Here a printer laid out the polished sheets of copper and cut a piece for the desired size of the chart. While large charts were cut to the exact size, smaller engravings were given a somewhat larger piece than might be required so as to provide an unhampered work area.

After the raw copper was polished and cut it was forwarded to the engraver assigned the task. He carefully inspected the copper to insure there were no flaws or blemishes. The care the engraver gave his copper was one of the key points in a long process designed to insure a high degree of quality as the copperplate engraving developed. After an inspection of the copper the engraver would begin his drawing by drafting a neat line around the chart area and the construction of the projection consisting of a framework of parallels and meridians. This procedure enabled the engraver to transfer accurately, by section, each figure and feature from the original field compilation.

It became apparent at an early date that suitable devices would be needed to insure proper printing. About the same time the Engraving Division was developing acceptable engraving techniques, a copperplate press was purchased in 1851. Production in the engraving section was still slow due to numerous changes in personnel. A format had to be established on the type of data to be engraved. Interest was stimulated by Hassler among the artistically inclined engravers through use of fine topographic detail in a series of "headland" sketches applied along the borders in otherwise blank sections of the charts. These sketches were coastal views providing pictorial artistry of shore features observed from sea. The use of incised lines drawn of shore areas with depth soundings had not provided sufficient challenge to the engravers, many of whom considered themselves artists of the highest degree. The headland sketches added character and vital information for the mariner and gained the admiration of the European cartographers for their American counterparts as worthy contemporaries in the field of map making.

Those aspiring to become engravers in the Coast Survey endured a vigorous trial period. No man lacking in the essential qualities of a nartist could reach the master's level as a first-class topographical engraver. The dramatically artistic views achieved by the Coast Survey engravers who fulfilled Hassler's ambitious goals of shoreline detail established a hallmark for future generations of Survey cartographers.

Many early sketches included locations of settlements with the familiar symbol of a church or other prominent structure drawn in somewhat exaggerated form to denote townships, lighthouses, forts, and other prominent structures associated with principal ports. These engraved features were so detailed that inspection under magnification will in some cases show buildings with small windows, street signs, trees with each branch in detail, and harbor views with masted ships at anchor. Harbor entrances included woodland as observed at a seaport entrance as well as other prominent topographic features and even perhaps the figure of an Indian or a village along the shoreline. The hydrographic information was equally important in the compilation of the charts and was of such accurate dimensions that the early charts compare favorably with modern day editions.

A comparison with maps and charts of the 19th Century origin accomplished by private concerns shows the early work of the Coast Survey as an entirely new concept in chartmaking. The most remarkable improvements were the uniformly high accuracy throughout, including hydrography and complete topography.

The evaluation of the nautical chart has kept pace with technological advances. The copperplate method of reproduction was successful in the flat-bed press, but it was not until the advent of offset lithography that its greatest growth occurred. Now the most widely used modern method of reproduction is photo-lithography. Lithograpic methods were employed in Coast Survey reproduction as early as 1897. Today all National Ocean Survey charts are reproduced entirely by modern photolithographic methods.

Advances in navigation and ship operation have dramatically increased demands for more complete and exacting charts. Today, more than two million charts are issued annually to compare with the total chart production of 169 copies for 1844, the first year in which actual chart production was achieved. This rate increased steadily until the Civil War, when the total annual output reached more than 50,000 copies. By the turn of the century, the volume increased to about 100,000 copies annually.

It is a fitting tribute to these masters of engraving that the last largescale use of the old copperplates should be for the reproduction of charts that will be issued in honor of America's bicentennial.

When the last chart of the last coastal state has been run off on the old printing press, the copperplates will be returned to the vault. There they will repose as treasured mementoes of a vanished art. From time to time, in the years ahead, one may be taken from the vault and a chart pulled off to honor a prominent individual—perhaps a president, a senator, a great American or a visiting dignitary. But never again, in all probability, will the old printing press be put to any great use.

1976 will mark the close of an era. □

SHRIMP

Sea Fare

BETTER BUY

Shrimp—long considered the United States' most popular shellfish—now are abundant as well.

Supplies have been extremely good in recent months, according to the National Marine Fisheries Service, and with the production season at its height favorable prices can be expected in the supermarkets.

These tender, delicate, and delicious shellfish are an excellent source of high-quality protein, contain many essential minerals, and are very low in fat content.

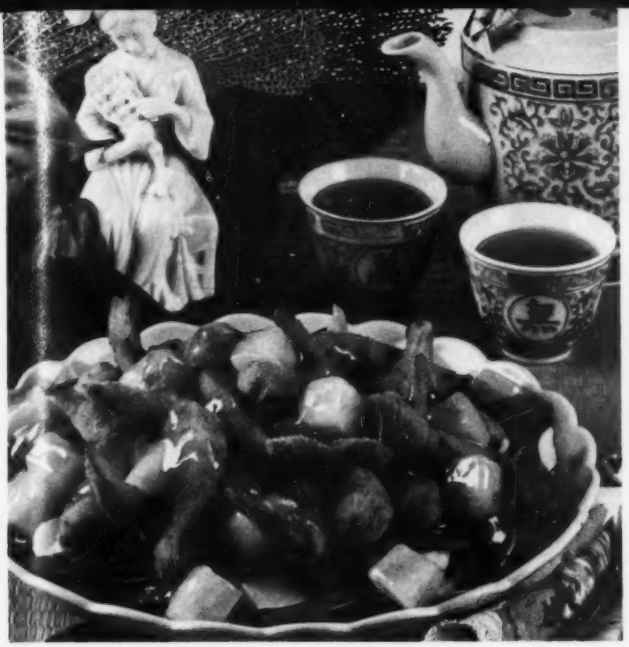
Once used principally in seafood cocktails, they are now known as one of the most versatile foods. Hors d'oeuvres, sandwiches, soups, chowders, salads, and main-dish entrees all benefit from the addition of shrimp.

Don't miss the shrimp boat this year, NMFS's National Consumer Educational Services Office urges, offering a selection of recipes for taking advantage of the shellfish bonanza.

Shrimp Rice Buffet Supper Salad

2 cans (4½ ounces each) shrimp
2 cups chilled cooked blanched rice
1 can (8 ounces) water chestnuts, drained and thinly sliced
1 cup diagonally sliced celery
½ cup sliced pitted ripe olives
¼ cup sliced green onions (with 2 inches of green tops left on)
1¼ cups salad dressing or mayonnaise
1 tablespoon lemon juice
1 teaspoon soy sauce
¼ teaspoon ginger
¼ teaspoon curry powder
Crisp salad greens
Tomato wedges or slices and black olives for garnish, optional

Drain shrimp; rinse in cold water and chill. Combine rice, water chestnuts, celery, olives, and green onions in large bowl. Combine salad dressing or mayonnaise, lemon juice, soy sauce, ginger, and curry powder; mix well. Pour over rice mixture; mix well. Chill at least 1 hour. Fold in shrimp. Serve on salad greens; garnish, if desired, with tomato wedges or slices and black olive wedges. Makes about 5 cups salad mixture, 4 to 6 servings.



Shrimp With Pineapple Sweet-Sour Sauce

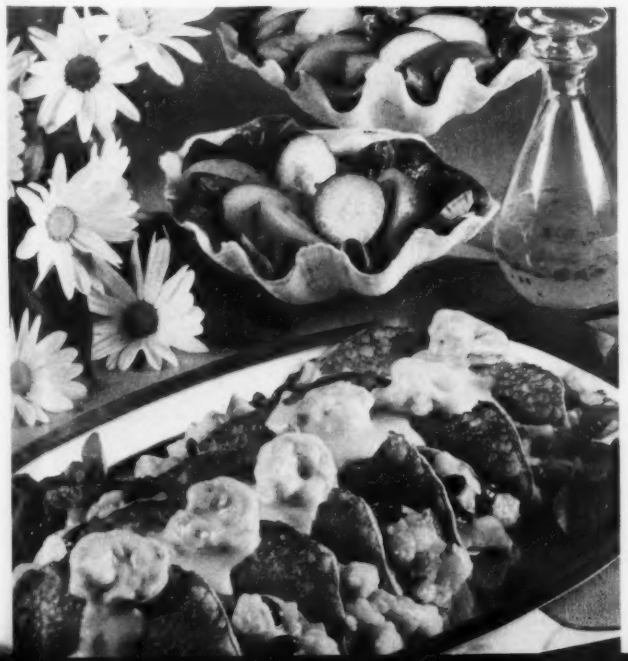
1 pound frozen, breaded shrimp (with or without tails)
Cooking oil
1 can (13¼ ounce) pineapple chunks
½ cup sugar
1 tablespoon cornstarch
½ teaspoon garlic salt
⅛ teaspoon ginger
⅓ cup vinegar
1 teaspoon soy sauce
2 packages (6 ounces each) frozen pea pods or oriental vegetables, cooked; or 4 to 6 servings hot, fluffy rice

Dip frozen shrimp in cooking oil. Arrange on shallow baking pan. Broil about 3 inches from heat, for 8 to 10 minutes, or until browned and hot. Turn once. Drain pineapple chunks; save syrup. Add water as needed to pineapple syrup to make ⅔ cup liquid. Combine sugar, cornstarch, garlic salt, and ginger in saucepan. Add liquids, vinegar, and soy sauce. Cook, stirring constantly, until clear and thickened. Fold in pineapple chunks; heat. Serve shrimp on vegetables or rice, spoon sauce over all. Makes 4 to 6 servings.

Shrimp With Mustard Butter

2 packages (10 ounces each) frozen breaded shrimp (with or without tails)
½ cup butter or margarine
¼ cup prepared mustard
2 teaspoons lemon juice
½ teaspoon garlic salt
Dash cayenne pepper

Cream butter or margarine; add mustard, lemon juice, garlic salt, and cayenne pepper; stir until thoroughly mixed. Spread both sides of frozen shrimp with mustard butter. Arrange on shallow baking pan. Broil about 3 inches from heat for 8 to 10 minutes, or until browned and hot, turning once. Spoon any remaining butter mixture on hot shrimp. Makes 6 servings.



Curried Shrimp Pancakes

1 pound frozen peeled deveined shrimp
½ cup finely chopped celery
¼ cup chopped onion
¼ cup butter or margarine
1½ cups chopped raw apple
¼ cup seedless raisins
½ teaspoon curry powder
1 can (10¾ ounces) condensed cream of shrimp soup
12 thin pancakes (recipe follows)
¼ cup half and half (half milk, half cream)
1 teaspoon lemon juice

Thaw frozen shrimp; chop half of the shrimp into small pieces; cut remaining shrimp in half lengthwise. Cook celery and onion in butter or margarine until tender, but not brown. Add apple, chopped shrimp, raisins, and curry powder; stir and heat thoroughly. Add ½ cup undiluted condensed soup; mix well and heat. Spoon equal amounts of filling (about 3 tablespoons) on each pancake and roll up. Arrange rolls on heatproof platter or shallow baking dish. Cover with aluminum foil, crimping it to edges of dish. Heat in moderate oven, 350° F., about 15 minutes or until serving temperature. Combine remaining soup, shrimp and half and half; heat. Stir in lemon juice. Serve over pancakes. Makes 12 rolled pancakes, 6 servings.

Pancakes

1 cup pancake mix
2 eggs
1¼ cups milk
3 tablespoons cooking oil

Combine ingredients; beat until smooth. Bake on lightly greased hot griddle, using about 3 tablespoonfuls of batter for each. Turn pancake when edges are dry and top is bubbly. Brown on second side. Makes 12 pancakes.

Shrimp Noodle Bake

1 pound frozen peeled deveined shrimp*
1 package (8 ounces) medium noodles, cooked and drained
½ pint (1 cup) dairy sour cream
1 can (10¾ ounces) condensed cream of mushroom soup
¼ cup sliced green onion (with 2-inch of green tops)
¼ cup sliced pitted ripe olives
1 teaspoon dill weed
½ teaspoon seasoned salt
1 cup shredded Cheddar cheese

Thaw frozen shrimp. Cut shrimp in half lengthwise, if desired. Combine noodles, sour cream, soup, onion, olives, dill weed, seasoned salt, and ½ of the cheese; mix well. Fold in shrimp. Spoon into shallow 2-quart baking dish. Cover with aluminum foil, crimping it securely to edges of dish. Bake in moderate oven, 350° F., 30 minutes. Uncover; sprinkle with remaining cheese. Return to oven about 15 minutes or until heated. Makes 6 servings.

*If desired, two pounds of shrimp with shells on may be cooked, shelled, and deveined for use in this recipe or 3 cans (4½ ounces each) of drained shrimp may be substituted.

Easy-Do Shrimp De Jonghe

2 packages (10 ounces each) frozen breaded shrimp (with or without tails)
⅔ cup butter or margarine, melted
½ cup dry white wine
2 cloves garlic, minced
2 tablespoons chopped parsley
2 teaspoons chopped chives
½ teaspoon paprika

Combine and mix melted butter or margarine, wine, garlic, parsley, chives, and paprika. Dip frozen shrimp into butter mixture. Arrange an equal amount of shrimp in shallow individual baking dishes or shells. Drizzle any remaining butter mixture over shrimp. Bake in very hot oven, 450° F., for about 15 minutes, or until hot and lightly browned. Makes 6 servings.

Shrimp Rice Bake With Feta Cheese

1 pound frozen peeled deveined shrimp or 2 cans (4½ ounces each) shrimp, drained
1 cup chopped onion
1 cup sliced celery
⅓ cup butter, margarine or olive oil
1 can (1 pound) tomato wedges
3 cups cooked rice
1 teaspoon dill weed or oregano
4 ounces feta cheese, crumbled*
½ cup sliced pitted ripe or Greek olives

Thaw frozen shrimp or rinse canned shrimp in cold water. Cook onion and celery in butter, margarine or olive oil until tender, but not brown. Add tomato wedges with juice; heat. Stir in rice, dill weed or oregano, ½ of the shrimp, cheese and olives. Spoon into shallow 1½-quart casserole. Top with remaining shrimp, cheese, and olives. Bake in modearte oven, 350° F., 25 to 30 minutes or until shrimp is cooked. Makes 6 servings.

*Feta cheese has a distinctive salty flavor not available in other cheeses and for a true Greek flavor it is desirable. If feta cheese is not available, try well drained large curd cottage cheese and add ¾ teaspoon salt to the rice.

Shrimp Tacos

2 packages (10 ounces each) frozen breaded shrimp (without tails)
12 taco shells
2 cups shredded lettuce
½ to ⅔ cup chopped onion
1 medium tomato, chopped
2 jars or cans (3 ounces each) taco sauce or prepare own sauce (recipe follows)
1 cup shredded Cheddar cheese
Sour cream, optional
Sliced avocado, optional

Remove tails from shrimp with kitchen shears or a sharp knife. Heat shrimp and taco shells as directed on each package. Portion lettuce, onion, tomato, and shrimp in taco shells. Cover each food with sauce. Sprinkle with cheese. If desired top with sour cream, an avocado slice, or both. Makes 12 tacos, 6 servings.

Taco Sauce

1 cup chopped onion
1 cup chopped green pepper
1 clove garlic, minced
2 tablespoons cooking oil
2 cans (8 ounces each) tomato sauce
1 teaspoon chili powder
½ teaspoon salt
⅛ teaspoon cayenne pepper

Cook onion, green pepper, and garlic in oil until tender, but not brown. Add tomato sauce and seasonings; stir. Simmer covered about 20 minutes or until flavors are well blended. Makes about 2½ cups sauce.

Shrimp and Broccoli Bake

1½ pounds raw shrimp, cooked, peeled, and deveined, or
3 cans (4½ to 5 ounces each) shrimp
⅓ cup commercial Italian dressing
¼ cup catsup
¼ cup finely chopped onion
2 tablespoons chopped parsley
2 packages (10 ounces each) frozen broccoli spears, cooked and drained
2 tablespoons butter or margarine
1 tablespoon lemon juice
½ cup finely shredded process American cheese (optional)

Rinse canned shrimp, if used, in cold water; drain well. Combine and mix Italian dressing, catsup, onion, and parsley. Pour over shrimp; mix carefully. Cut broccoli stems into small pieces. Arrange in bottom of shallow 1½ quart baking dish. Arrange broccoli flowerettes at either end of casserole. Melt butter or margarine; stir in lemon juice. Drizzle over broccoli. Spoon shrimp mixture between broccoli flowerettes. Cover with aluminum foil, crimping it to edges of dish. Bake in hot oven, 400° F., about 20 minutes or until hot. Uncover; sprinkle with cheese, if desired. Return to oven to melt cheese. Makes 6 servings.

Shrimp and Asparagus Luncheon Salad

2 cans (4½ ounces each) shrimp, rinsed and drained, cut in half lengthwise, if desired
1 cup sliced celery
1 can (8 ounces) water chestnuts, drained and sliced
1½ pounds fresh asparagus spears, or 2 packages (10 ounce) frozen asparagus spears, cooked and drained
½ cup salad oil
⅓ cup lemon juice
2 teaspoons finely chopped onion
½ teaspoon salt
½ teaspoon crushed rosemary
½ teaspoon basil
¼ teaspoon paprika
⅛ teaspoon dry mustard
Crisp salad greens
4 hard-cooked eggs, sliced
Pimiento strips

Combine shrimp, celery, and water chestnuts in bowl or refrigerator dish. Place asparagus spears in shallow dish. Combine salad oil, lemon juice, onion, salt, rosemary, basil, paprika, and dry mustard; mix well. Divide oil mixture evenly between shrimp and asparagus; cover. Chill at least 1 hour. Arrange drained asparagus on salad greens on salad plate. Top with drained shrimp salad mixture and egg slices. Garnish with pimiento strips or pieces, as desired. Makes 6 servings.

noaa/update

ERL, NWS TEST NEW TORNADO DETECTOR IN 'ALLEY' AREAS

Twenty sites along America's "tornado alley" will test this summer a new and significantly improved electronic tornado detector developed by NOAA.

The compact (office typewriter-sized) instrument and its four-antenna array constitute the latest model of a device which has been evolving since 1971 in the Wave Propagation Laboratory, one of NOAA's Environmental Research Laboratories.

Sites selected for the 1974 tests are at officers of NOAA's National Weather Service and the National Severe Storms Laboratory in Norman, Okla.

According to William L. Taylor, who leads the project for the Wave Propagation Laboratory, the new design provides a directional indication in addition to detecting the existence of the electrical "bursts" associated with tornado-bearing thunderstorms.

"The system we're putting into field this year," he says, "uses a four-cornered array of antennas, instead of the former omnidirectional antenna used in the old unit. By sensing the sequence with which the signal crosses the antenna array, we can determine the 45-degree sector from which the signals are emanating. This means that Weather Service personnel, for example, can intensify their radar scan in the indicated area, call people there, and generally get ready for the possibility of a tornado warning operation."

During 1972, the omnidirectional units detected about three out of four reported tornadoes, but also gave tornado alarms in which only about one alarm in five could be linked to a reported tornado. Similar results were obtained in 1973, with the detector "seeing" only about three reported tornadoes in every five. However, last year the detector false alarm rate was down to one tornado reported for every three alarms.

"We now know," Taylor says, "that the electrical signals we detect are not associated with the vortex (whirlwind) motion in the storm that eventually produces a tornado, but come from another, unidentified source within the main body of the storm. The source and the area of tornado activity may be separated by several miles.

William L. Taylor of ERL calibrates one of his new electronic tornado detectors. This latest model senses the electrical impulses emanating from a tornadic thunderstorm, and also shows the general direction from which the signals are coming.

"We also have indications now that the electrical signals emanating from a severe storm vary from one geographic region to another. For example, we get our best detector performance along tornado alley, where the storms and tornadoes run to the large, violent, highly electrical types. Down along the Gulf, where relatively weaker maritime thunderstorms produce many of the tornadoes, we don't do as well, but we think this problem can be calibrated out of coastal detectors."

The tornado sensors are wideband receivers operating over a frequency band from 10 to 80 megahertz (million cycles per second) for two threshold levels corresponding to signal amplitudes expected at ranges out to 12 miles (20 kilometers) and 43 miles (70 kilometers) from the instrument. Directional sectors are indicated only for signals at ranges between 12 and 43 miles. For signals from sources closer than 12 miles, the equipment indicates only that the signals are local. The system uses an array of four antennas located by the corners of a 20-foot (6-meter) square.

Received impulse signals are converted to logic pulses and delivered to an integrating circuit for each sector. Signals can be partitioned into the proper sector simultaneously for all directions at rates up to about 100,000 per second.

If the number of signals arriving within the azimuthal limits of a sector exceeds a rate of 500 per second, one burst is counted. When there is an increase in the number of bursts, a white-colored rate-increase light turns on. When a burst rate of 15 per minute or greater is detected — the warning level for possible tornadic activity — a red warning light comes on.

"Based on our experience thus far," Taylor says, "a white light indicates that thunderstorm activity in the sector shown is increasing. The longer a white light stays on continuously, the greater the probability that the warning level will be reached. Then observing precipitation returns on weather radar, individual storms can be identified as electrically active — as potential sources of tornado activity.

"A red light and audible alarm indicate that thunderstorm activity in the sector has reached a level associated with tornado generation. These signals do not mean a tornado is on the ground at the time, but that a high probability exists for a tornado to form within a few minutes."

Gray Whale Count By NMFS Stands At Seven-Year High

The 3,492 gray whales counted off the California coast from December 18, 1973, through February 4, 1974, during the annual southward migration represents the highest total since the count began seven years ago, it has been revealed. The annual census is taken by the National Marine Fisheries Service at Yankee Point, near Monterey, California.

The count begins each year around mid-December as soon as whales are seen regularly during their southerly migration and continues until statistics indicate that most have passed the observation point, and only an occasional straggler is sighted. Some gray whales begin leaving Arctic waters as early as October, moving toward the calving lagoons in Baja California.

The total number of gray whales counted this season (December 14, 1973, to February 9, 1974) was 3,919, but the year-to-year population trends are best illustrated by comparing the counts for the period of time included in each year's tabulation — December 18 through February 4, excluding Christmas and New Year's Day. For the comparable dates, the 3,492 whales counted were about 15 percent above the previous six year average.

Year	*Count*
1967-1968	3,120
1968-1969	3,081
1969-1970	3,064
1970-1971	3,034
1971-1972	2,588
1972-1973	3,304
1973-1974	3,492

The count was made under the direction of Allen Wolman of the NMFS Northwest Fisheries Center, Seattle, Washington: The "whale watch" is made from shore during the hours of 7:00 a.m. to 5:00 p.m by two observers using powerful binoculars.

Coastal Zone State Grants Announced

Secretary of Commerce Frederick B. Dent announced the award of the first three NOAA coastal zone management grants, at Charleston, S.C., during a meeting on "The Coastal Imperative."

A total of $634,547 went to Rhode Island, Maine, and Oregon to assist them in developing coastal zone management programs. In the weeks that followed, grants for an additional $2,579,355 were awarded to eight states on the east, Gulf, and Pacific coasts and the Great Lakes.

On the east coast, the Maine grant was awarded to the Office of State Planning and will support the work of the Departments of Marine Resources, Inland Fisheries and Game and Conservation. Rhode Island's Department of Administration will use that state's grant to support activities of the Coastal Resource Management Council and the University.

The Coastal Zone Planning and Management Council of the State of South Carolina administers NOAA's coastal zone management grant to that state.

On the Gulf Coast, Texas will use the first year of its NOAA grant to make inventories of groups with interests in coastal zone management, of present coastal zone management authority in the state, and of existing data on all aspects of the Texas coastal zone.

Also on the Gulf Coast, Mississippi will use its NOAA grant funds under administration of the Mississippi Marine Resources Council.

Oregon, first Pacific coast state to receive a NOAA coastal zone management planning grant, will use a major portion of the funds to support operations of the Coastal Conservation and Development Commission.

The State of Washington has earmarked the first year of its NOAA coastal zone grant funds for the collection and compilation of basic shoreline data.

The grant to California will be administered by the California Coastal Zone Conservation Commission.

The states of Michigan and Ohio on the Great Lakes received NOAA grants for coastal zone management.

TAG FINDS POSSIBLE ORE DEPOSITS ON SEA FLOOR

An intensive study of the undersea source of manganese-rich rocks has confirmed the existence of what appear to be widespread metallic mineral deposits over some 40 square miles of the median valley of the Mid-Atlantic Ridge.

The investigation, conducted by scientists with NOAA and from several universities, has established that manganese-rich samples dredged from the same Ridge location two years ago were not anomalous, but part of a larger mineral-concentrating process which is still active.

Those samples, taken during the 1972 field season of NOAA's Trans-Atlantic Geotraverse, or TAG program, were purer and accumulated one hundred times faster than other manganese deposits taken from the seafloor in other regions.

They were also the first hydrothermal mineral deposits discovered in the median valley of a mid-oceanic ridge. (Hydrothermal activity is the mineral-forming process that results when hot liquids carrying dissolved metals circulate through openings in rocks and deposit concentrations of metallic minerals.)

Perhaps most important, according to Dr. Peter A. Rona, who directs the TAG program for the Atlantic Oceanographic and Meteorological Laboratories in Miami, Fla. (part of NOAA's Environmental Research Laboratories) is that the deposit defined by the 1973 field work the area now called the "TAG Hydrothermal Field"—occured where plate tectonic theory says it should have.

"The TAG Hydrothermal Field," Rona says, "is an important clue to how the forces that rift continents apart and cause the sea floor to spread are related to the formation of metallic mineral deposits. We have determined how these relationships operate for the earliest growth stage of an ocean basin —the Red Sea stage, where the African crustal plate and the Eurasian plate are just beginning to diverge. But we have been less certain about how well these relationships apply to the mid-ocean ridge system, which is the most advanced stage of a boundary between diverging plates. We would think that this 47,000-mile-long undersea mountain chain, which is continuous through all the major ocean basins, would be the site of metallic mineral concentration, as new material continued to well up from the earth's interior.

"The TAG Hydrothermal Field confirms this, indicating that our model of a diverging ocean floor works for the mid-ocean ridge stage as well as for the Red Sea stage."

Further proof of this linkage between continental drift and oceanic minerals should come from further study of the way the hydrothermal deposits are dispersed outward from the seafloor spreading center of the Mid-Atlantic Ridge.

"Because the seafloor is spreading," Rona says, "we would expect that a mineral deposit on the ridge would extend in a long narrow zone from the ridge, across the ocean basin, to the adjacent continental margin, provided the process is a continuous one." Thus, the TAG Hydrothermal Field may be only the centerpiece of a strip of manganese-rich deposits running across the Atlantic seabed.

Deaths Of Magnetic Storms Probed By ERL Scientists

During a magnetic storm, a river of immensely hot charged particles forms and flows around the earth, a mammoth ring of electric current encircles the equator,high above the surface of the planet. The ring of current generates a magnetic field that temporarily cancels the earth's field.

But the ring soon fades. The main phase of a magnetic storm, when the strength of the earth's field plummets, lasts only a few hours. Then, over the next few days, magnetic conditions return to normal in the recovery phase. Now, NOAA scientists have mapped out the legend structure of the ring current and learned some of the "why" of its demise. Drs. Donald J. Williams and L. R. Lyons of the Environmental Research Laboratories used satellite observations to spy on the protons in the ring current.

The ring current fizzles as its charged particles escape into space, and the two NOAA scientists have uncovered one of the escape routes. The ionized (electrically charged) gases in the ring current are extremely hot, with temperatures in the millions of degrees. When it forms, the ring current takes up residence next door to a population of cooler ionized gases, or plasma, that are permanent residents of a zone of the magnetic field called the plasmasphere. The gases of the plasmasphere, which is actually an extension of the ionosphere (the electrically charged upper atmosphere), are a mere several thousand degrees in temperature. The protons of the ring current, say Williams and Lyons, slip away in the confusion that ensues when the high-temperature intruders meet the cooler natives.

The National Aeronautics and Space Administration's Explorer 45 satellite travels around the earth in an elliptical orbit nearly matching the equatorial plane, and so provides a good view of the ring current. Instruments on the satellite measured the distribution of protons in the ring current before, during, and after a major magnetic storm that occurred on December 17, 1971.

A surge in the solar wind seems to be what sets off a magnetic storm and causes the ring current to form. As the initial force of the solar surge dies, explains Williams, director of the Space Environment Laboratory, a large stable residue is left behind and persists in the ring current.

From the Explorer 45 observations, the NOAA scientists found that different processes are occuring in different parts of the ring. In the inner reaches of the ring, closest to earth, the hot plasma interacts with the cold plasma of the plasmasphere. The interaction creates instability, and protons are diffused and escape from the magnetic field.

noaa/people

Raymond J. Edwards is the new Official in Charge at the National Weather Service office in Bridgeport, Conn.

Commander Wesley V. Hull has been elected President of the Executive Committee of the National Association of Commissioned Officers, an organization composed of members of the NOAA Corps.

Charles Kearse and **Thomas Bartholomew** have been named branch chiefs in the National Ocean Survey's Engineering Development Laboratory. Mr. Kearse is responsible for the Ocean Enginering Branch in Miami, Fla. Mr. Bartholomew heads the Instrument Systems Development Branch in Rockville, Md.

Ernest E. Tillotson is the new Manager of the National Weather Service Meteorological Observatory at Omaha, Nebr.

Lieutenant Commander Merritt N. Walter, Lieutenant (junior grade), Michael S. Bohle, Lieutenant (junior grade), Theodore C. Kaiser and Lieutenant (junior grade) Kurt X. Gores have completed a special marine fisheries training program at the University of Rhode Island, to familiarize NOAA Corps officers with the design and operation of fishing gear and equipment used on NOAA ships engaged in fisheries research and surveys.

Dr. Heinz W. Kasemir and **E. L. Magaziner,** both of the Environmental Research Laboratories' Atmospheric Physics and Chemistry Laboratory in Boulder, Colo., recently participated in the Apollosoyuz Test Project Lightning review at the Kennedy Space Center. The launch of the cooperative American–Soviet space rendezvous is scheduled for an afternoon in mid-July 1975 when lightning danger to the space vehicle will be high.

Mrs. Phyllis A. Polland is the new Meteorologist in Charge of the Pensacola, Fla., office of the National Weather Service.

Captain Leonard S. Baker, Director of the National Geodetic Survey, has been elected by the American Congress on Surveying and Mapping as its vice president.

Dr. C. Gordon Little, Director of the Environmental Research Laboratories' Wave Propagation Laboratory in Boulder, Colo., has been elected to the National Academy of Engineering.

Donald M. McGuire has joined the staff of the Environmental Data Service as an assistant and advisor to the Director in developing and maintaining liaison with other components of NOAA and other Federal agencies.

Carleton Coulter, III, has been appointed Chief, Facilities Engineering Group on the staff of the Administrative Operations Division at NOAA Headquarters.

Harold L. Goodwin, Deputy Director of the Office of Sea Grant, has been awarded the American Littoral Society's James Dugan Memorial Award, presented annually for outstanding service in the aquatic sciences.

Ben P. Barker, Jr. has entered on duty as Official in Charge at the National Weather Service Office in Tulsa, Okla.

Donato Del Proposto, Jr., has been named Chief of the Computer Services Division of the National Ocean Survey's Lake Survey Center.

James H. Czerwonky has joined the National Marine Fisheries Service Plans and Policy Development Staff as an analyst.

David H. Livingston has been selected to head the Macon, Ga., office of the National Weather Service.

Captain Joseph M. Kelly, USCG, has been appointed Deputy Director of the National Ocean Survey's national ocean buoy program. He will head a detail of Coast Guard officers who work with NOAA personnel on the program and provide ship and communications support.

Zoologist **Dr. William J. Richards,** of the NMFS, has been appointed Editor of the *Bulletin of Marine Science,* which is published by the Rosenstiel School of Marine and Atmospheric Science at the University of Miami.

Dr. Robert S. Dietz, a research oceanographer with the Miami-based Atlantic Oceanographic and Meteorological Laboratories, has been elected a fellow of the American Geophysical Union.

William A. Rammer has been appointed Meteorologist in Charge of the Great Falls, Mont., Weather Service Forecast Office.

Rear Admiral Alfred C. Holmes has been named to the Executive Board of the Federal Executive Association of the Greater Tidewater area of Virginia. He is Director of NOAA's Atlantic Marine Center in Norfolk.

Mike Christian, a marine enforcement officer with the National Marine Fisheries Service's D.C. headquarters, was graduated first in his class at completion of courses at the Treasury Department's Criminal Investigator School in Washington.

Lawrence Niemeyer, on assignment from the Environmental Research Laboratories' Air Resources Laboratory, has been appointed director of the Meteorological Laboratory for the Environmental Protection Agency's National Environmental Research Center at Research Triangle Park, N.C.

John B. Smith, Leading Forecaster at Phoenix, Ariz. Weather Service Forecast Office, is the new Meteorologist in Charge at the Weather Service Office, Pendleton, Oreg.

Edward P. Devine, Chief of the Aeronautical Information Branch in the National Ocean Survey's Aeronautical Chart Division, has returned from a one year assignment to the United Nations, as a UN cartographic consultant to the Survey of India in Hyderabad and later as a cartographic specialist at UN headquarters in New York.

Lieutenant (junior grade) Robert E. Losey has joined the Environmental Research Laboratories' Boulder, Colo.-based Space Environment Laboratory for a six-to-eight month training period.

Lieutenant (junior grade) Burl L. Westcott is Official in Charge of the National Ocean Survey's National Geodetic Survey office in Anchorage, Alaska.

Richard A. Wood has been appointed Official in Charge of the Tucson, Ariz., Weather Service Office.

Commander Phillip C. Johnson has been appointed Commanding Officer of the NOAA Ship *Ferrel.*

Joan Maier, Chief of Library Services for the Department of Commerce's Boulder Laboratories in Colorado, has been named the local chairman of the National Special Libraries Association Conference to be held in Denver in June 1976.

Richard P. Augulis has been selected for Meteorologist in Charge of the newly established Weather Service Forecast Office at Fairbanks, Alaska.

Dr. Aaron L. Shalowitz has received the Honorary Member Award of the American Congress on Surveying and Mapping (ACSM).

Chung Yun Chiang has joined the Lake Survey Center as Chief of its Revisory Section.

Lieutenant Donald L. Suloff is the new Operations Officer of the NOAA Ship *Peirce.*

Lieutenant (junior grade) Patrick L. W. Wehling, Jr. is the new chief of the National Ocean Survey's Astronomical Party G–47.

Max R. Cagle, Meteorologist in Charge of the National Weather Service Radar Observatory and Service Office in Hatteras, N.C., since 1966, will head the National Weather Service Office at Blountville, Tenn.

Lieutenant Commander William R. Daniels is the new Executive Officer of the NOAA Ship *Whiting.*

Commander Richard J. DeRycke is the NOAA Ship *Mt Mitchell's* new Executive Officer.

Kentucky Governor Honors Agricultural Forecasters

Kentucky Governor Wendell H. Ford (right) recently presented a "Service to Agriculture Citation" for "Outstanding leadership and unselfish and diligent service to Kentucky's basic industry, AGRICULTURE," to the Agricultural Forecasters for Kentucky at the Louisville Weather Service Forecast Office. John R. Burke (center), Meteorologist in Charge at Louisville, accepted the citation. On the left is Wendell P. Butler, Kentucky's Commissioner of Agriculture.

Sky Probe Aiding Study Of Oceans

A newly developed "ocean-tuned" sensor recently tested by NOAA scientists may have brought man a step closer to monitoring ocean currents and river outflow from space.

The remote-sensing device, developed by the National Aeronautics and Space Administration's Goddard Space Flight Center, is designed to collect data from the oceans in the same way that the Earth Resources Technology Satellite (ERTS) gathers information from land. The instrument is similar to one that is expected to fly aboard the experimental Nimbus-G satellite, and is considered a forerunner to instruments carried by sea-watching satellites planned for the future.

The tests were conducted by oceanographers from the Atlantic Oceanographic and Meteorological Laboratories aboard the Research Flight Facility's C–130 aircraft.

Scientists from the University of Miami and Nova University also were involved in the tests.

According to George Maul, an oceanographer with NOAA's Physical Oceanography Laboratory (one of the Miami laboratories), the instrument is of particular interest for detecting variations in ocean color—something the multi-spectral scanner aboard ERTS does in a more limited way.

The instrument's 10 bands are all in the visible region of the spectrum—that is, from just into visible blue from ultraviolet to just losing visible red—compared with the four-channel scanner aboard ERTS, which has only two bands in the visible region, Maul explains. This capability is important for detecting variations of blue color in ocean areas.

The multi-spectral scanner was developed primarily for use in coastal zone mapping—detecting water quality changes and estuarine circulation. "By comparing the remote-sensing data gathered by the multi-spectral scanner with ground truth samples of the water—collected by buoys or ships—we can predict what the sediments are on a much broader scale for a specific region," says Maul.

Man-Made Pollution on Rise But Reversible Say GRL Scientists

If man continues to inject aerosols—fine airborne particulate matter—into the atmosphere at the present ever-increasing rate, the amount of manmade aerosols in the atmosphere may equal natural aerosols within 23 years.

This is one of the conclusions two NOAA scientists reached after drawing together and analyzing data collected by other investigators on the aerosol emissions from various sources and the effects of different concentrations on worldwide climate.

The two believe, however, that man's current efforts at pollution abatement can bring the situation under control before 23 years pass.

Ash from volcanic eruptions, salt from the oceans, dust blown up from the soil, all add aerosols to the atmosphere. Nature's aerosols have long influenced the weather and the worldwide climate. Now, however, man with his factories and vehicles is supplementing nature's supply of aerosols, with potential effects on local weather and world climate. Aerosols are already affecting weather on a local scale, the two note, adding that "inadvertent weather modification on a scale large enough to affect man's well-being might soon become a reality."

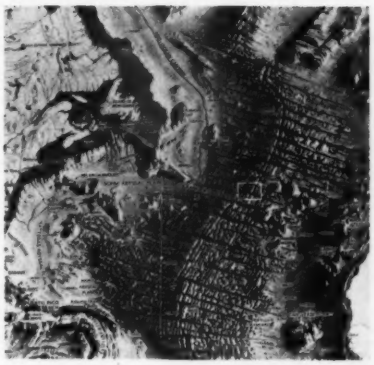
Drs. Helmut K. Weickmann and Rudolf F. Pueschel, atmospheric scientists with the Environmental Research Laboratories, have calculated the amount of time different aerosols remain in the atmosphere and what their effects might be. The two, with the Atmospheric Physics and Chemistry Laboratory in Boulder, Colo., conclude that man-made aerosols account for only a small proportion of the total now in the atmosphere

The effect a given aerosol will have on climate, explain Pueschel and Weickmann, who is director of the Atmospheric Physics and Chemistry Laboratory, depends in large part on how long it remains in the atmosphere. Some aerosols, such as lead from car exhaust, are rapidly removed by precipitation. Others may remain in the stratosphere for months or years.

Scientists at Stanford University estimate that natural processes produce about 2,312 million tons (2,097 million metric tons) of aerosols a year, which amounts to about 88.5 percent of the total. Man and his activities add another 296 million tons (269 million metric tons).

But aerosols from natural sources are distributed fairly evenly across the planet, with concentrations over the oceans roughly equal to those over the land. Man, in contrast, contributes high concentrations, mostly from industrial centers. Because of the lopsided distribution of the world's industrial centers, which are concentrated in the eastern United States, Eurasia, Japan, and part of Australia, say the researchers, "we find that the 296 million tons of manmade aerosols are produced every year on only about 2.5 percent of the surface of the globe."

Submersibles Begin Mid-Ocean Ridge Study



The most extensive surface feature on earth, the Atlantic Mid-Ocean Ridge, is being examined by U.S. and French scientists in research submersibles 200 miles southwest of the Azores. Purpose is to seek scientific clues to the origin of the earth's crust, conditions under which metallic ores are formed, and the nature of mid-ocean earthquakes. Project FAMOUS (French-American Mid-Ocean Undersea Study) operating area is shown by white square in graphic representation (above, left); two of three submersibles are France's Cyana (center), and the Navy's Alvin, operated by Woods Hole Oceanographic Institution.

U.S. Chief Scientist is Dr. James Heirtzler of Woods Hole Oceanographic Institution; the U.S. portion of the project is sponsored by NOAA, the National Science Foundation, and the Navy.

Photo Credits: Map: (c) 1973 National Geographic Society
Saucer sub: National Center for Exploitation of the Oceans (France)
Alvin: Woods Hole Oceanographic Institution

NGS MEASURES LAND IN 18 U.S. STATES, FIXES BOUNDARIES

A corps of about 180 geodetic engineers and technicians from the National Geodetic Survey will conduct land measurements this year in 18 states, from the mid-Pacific to the Atlantic and from the Canadian border to the Rio Grande. They are continuing a survey of the country that began in 1817 on Long Island, New York.

The geodetic surveys will be conducted this year in Alaska, California, Connecticut, Delaware, Georgia, Hawaii, Louisiana, Maryland, Michigan, Mississippi, New York, Tennessee, Texas, Utah, Virginia, Washington, Wisconsin and Wyoming. In addition to normal geodetic survey operations, survey teams will fix the location of the U.S.-Mexican and Maryland-Delaware boundaries.

During the past century and a half, these surveyors have measured the latitude, longitude, and height above sea level of approximately 500,000 sites throughout the United States. A bronze plaque marks each site. It denotes the starting point from which accurate measurements can be made.

The measurements of distances are so accurate—even the curvature of the earth is taken into consideration—that the surveyors err by only about one-half inch in 10 miles, using laser instruments employing the speed of light to ensure accuracy. Measurements of elevations are similarly accurate.

The geodetic field forces are divided into eight major field parties averaging 20 men each. Each field party moves from one location to another, accompanied in many cases by wives and families. Projects are planned to take maximum advantage of good weather since the survey work is performed outdoors. The parties therefore move from north in the summer to south in the winter. Surveyors' children may attend as many as 50 schools before graduation.

The parties which measure elevations can usually be recognized by the umbrellas they use to shield their delicate surveying instruments from the sun's rays. They wear orange vests to alert traffic to their presence. The parties measuring distances work at night when atmospheric distortion is less, from atop portable steel towers, which often rise to 12 stories or more above the ground. The towers enable the surveyors to overcome the effect of the earth's curvature.

In addition to the surveying parties, a dozen technicians are entrusted with the maintenance of the existing half-million geodetic markers which dot the country's plains, valleys, and mountains and cost $500 to $5000 to replace. The country is divided into 12 districts and each maintenance man covers about four states. All 50 states are visited.

ALASKA TIDAL BORE SOUGHT BY SURVEY

NOAA will investigate this summer the apparent disappearance of an Alaskan tidal bore. One of nature's most unusual and awesome phenomena, it was last reported seen in the 1930's.

The investigation will be conducted by the hydrographic survey ship *Rainier* in a waterway known as Knik Arm, a branch of Cook Inlet, gateway to Alaska's largest port, Anchorage.

Bores occur in a relatively few localities well scattered around the world. At its worst, a tidal bore is a foaming, churning, wall of water advancing upriver from the sea, its force probably accentuated by a lessening in depth and the narrow confines through which it moves. At its weakest, it has the appearance of a small wave or series of waves.

A preliminary investigation last year by the National Ocean Survey failed to turn up evidence of a bore in Knik Arm.

An air mission, on a photographic assignment in the Anchorage area was prepared last year to take photographs of the bore if it occurred, but the opportunity did not present itself.

Gamefish Tag Task Shared With WHOI

Tagging of large Atlantic game fish for scientific study is now the dual responsibility of the Woods Hole Oceanographic Institution and NOAA.

The 20-year-old Cooperative Game Fish Tagging Program, pioneered in the Atlantic by the Cape Cod institution has been restructured as a cooperative effort to be shared by private scientists and Federal investigators stationed at NOAA's National Marine Fisheries Service Southeast Fisheries Center, Miami.

Information collected through game-fish tagging programs is important to the study and evaluation of the life cycles of large, wide-ranging species, and eventually is translated into scientific recommendations for the rational management and conservation of a valuable natural resource.

Marlins, sailfish, tunas, and other highly valued game fish have figured prominently in tagging studies undertaken since the early 1950's by the Cooperative Game Fish Tagging Program, and a significant body of information now exists concerning their biology, ecology, population dynamics, and migratory habits. Thousands of these fish have been tagged and released, and many have been recaptured over two decades of voluntary participation by Atlantic anglers and marine researchers, with the support of sport and scientific organizations. These include the Sport Fishing Institute, NOAA's Office of Sea Grant, the National Science Foundation, and the Bureau of Commercial Fisheries (which became the NMFS in 1970.)

Recaptured tags, returned to project scientists from fishermen in widely separated regions, have made possible analyses of the migratory routes followed by many prized and hotly pursued sport and food fish. Findings reveal, or instance, that certain stocks of white marlin apparently spend the winter off the northern coast of South America, then migrate to the mid-Atlantic coast of the United States in summer and early fall. Another group appears to spend the summer in the northern Gulf of Mexico. Giant bluefin tunas tagged off the northeastern United States and recaptured off Norway provide documentation of trans-Atlantic migrations.

COOK INLET SURVEYS SPED; DEMAND HEAVY

NOAA marine surveys in Cook Inlet will be speeded up this year as a result of increased activities in the waterway leading to Alaska's main port of Anchorage.

Three ships will be assigned to the task in place of the two which have heretofore been surveying the waterway. They are the Seattle-based *McArthur*, *Fairweather* and *Rainier*.

Two types of surveys are being conducted in Cook Inlet by the National Ocean Survey.

A survey of tides and currents began last year and was designed as a five-year program. The progress made by *McArthur* in Lower Cook Inlet was so great, however, that it is anticipated now the program will be completed in four years. The *McArthur* will work this year in the northern portion of Lower Cook Inlet, between Anchor Point and the Forelands. The survey will continue next year in Upper Cook Inlet.

Hydrographic surveys are being made that will result in new large-scale coverage for navigation. The surveys will also be used to update existing nautical chart coverage and to provide a new data base for use in ecological, pollution, engineering, fisheries and scientific studies. These surveys, which have been underway since 1965, will be conducted by *Fairweather* and *Rainier* in both Lower and Upper Cook Inlet.

The step-up in marine surveying in Cook Inlet is being made in response to increased demands for circulatory and hydrographic data.

The need for more extensive and accurate marine data is accentuated by the increase in oil drilling, the use of supertankers to transport the oil, and the ever-present danger of oil spills and their threat to the area's wildlife and ecological balance.

noaa/update

DOMES PROJECT STUDIES ECOLOGY OF DEEP SEA

Within a decade, commercial ships may be mining the mineral wealth from the floor of the Pacific Ocean, possibly with varied —and poorly understood—effects on marine life and environment. NOAA scientists working with university colleagues, plan to launch a long-range project to determine what these effects will be, and how to minimize any potentially destructive impact on deep-sea ecology.

Called the Deep Ocean Mining Environmental Study, the developing project is under the direction of John W. Padan of the Pacific Marine Environmental Laboratory in Seattle.

The project is planned to focus on an area of the deep ocean floor in the North Pacific where surface layers of high-grade manganese nodules have attracted the attention of the mining industry. These nodules contain copper, nickel, and cobalt, as well as manganese. Preliminary assays of the nodules in the North Pacific showed the metals in higher concentrations than some ores now being mined on land, and a number of corporations are considering mining there early in the next decade.

The first step in the project is to establish baselines—exhaustive environmental descriptions of the pre-mining state of the water column and the top layer of sediment at selected sites in the nodule zone.

The first baseline study was conducted with the City College of New York. On April 12, a team of 14 oceanographers led by Dr. Oswald A. Roels of City College and Columbia University's Lamont-Doherty Geological Observatory, departed from Honolulu on the University of Hawaii's new research ship *Moana Wave*. A ten-day cruise carried the team to the research site, about 850 miles (1,360 kilometers) southeast of the island of Hawaii. There they spent two weeks collecting biological, chemical, geological, and physical data in a 10,000-square-mile (26,000-square-kilometers) patch of ocean centered on latitude 8 degrees North, longitude 151 degrees West.

At least two other sites, located in areas with different oceanographic characteristics, were subjected to similar scrutiny. The next step planned for the project is to monitor industrial tests and prototype mining operations.

After such mining tests, NOAA would continue to observe the sites, to see whether the ecology returned to "normal" after mining operations ceased and how long the process required. Experiments in shore-based laboratories would help define the mechanisms by which mining could alter the environment.

U.S. Fish Consumption, Prices, Set Records

Americans are eating more fish than at any time since the Federal Government began keeping records in 1909, according to preliminary figures released by the National Marine Fisheries Service.

The 1973 statistics indicate that the average per capita consumption of seafood was 12.6 pounds—an increase of slightly more than 2 percent, or three-tenths of a pound per person over the 1972 figure. The 12.6 figure includes edible fish (fresh, frozen, canned, or cured) that entered usual commercial channels from all sources, and represents about 2.6 billion pounds of fish, edible weight.

The increase can be attributed largely to a rise in consumption of fresh and frozen products, and to a lesser extent, canned fishery products.

The data indicate that total U.S. commercial fisheries landings (products used for both edible and industrial purposes) were worth a record $907.4 million to the fishermen. The total volume, approximately 4.7 billion pounds, was almost the same as in 1972, but the value was up about 29 percent from a year ago because of higher prices paid at dockside. The 1973 average value per pound of 19.2 cents for all species also was a record high.

Total imports of fishery products reached a record high value of $1.57 billion, up from $1.49 billion a year earlier. Imports of edible fishery products were 4.7 billion pounds, up from 4.4 billion pounds in 1972. Industrial fishery products imported by the United States declined sharply, from 4.6 billion pounds to about 800 million pounds. The drop reflects the world shortage of fishmeal, especially the decline in production by Peru which suffered a severe failure in its anchoveta fishery.

There were record U.S. harvests of anchovies, Pacific shrimp, surf clam meats, and snow crabs. Increased landings of bonito, Atlantic cod, croaker, Pacific sea herring, striped bass, pollock, rockfishes, scup, and whiting also contributed to the greater volume. Sharp declines occurred, however, in landings of yellowtail and Pacific flounders, Atlantic sea herring, jack mackerel, albacore tuna, bluefin and skipjack tuna, pink salmon, hard blue crabs, dungeness crabs, Gulf shrimp, and squid. There were also slight declines in landings of haddock, Pacific halibut, menhaden, red salmon, and oysters.

Weather Modifiers Report Projects

Rain, snow, fog, and hail were primary targets of weather modification during a recent 14-month period.

The 67 reported weather modification projects conducted in the Nation between November 1, 1972, and December 31, 1973, took place in 19 states. Oklahoma and California had the most, 12 and 11 respectively. North and South Dakota followed with six each; Idaho, five; Washington, four; Michigan, Texas and Utah, three each; Iowa, Montana, Oregon, and Wyoming, two each; and Arkansas, Colorado, Illinois, Nebraska, Nevada, and New York, one each.

Under a law that took effect on November 1, 1972, all nonfederally sponsored weather modification activities conducted in the United States and its territories must be reported to the Secretary of Commerce. NOAA administers the reporting program on behalf of the Secretary.

Nearly half of the reported projects were intended to increase precipitation, while about a fourth were conducted to dispel fog. Airlines and airport authorities sponsored operational fog-dispersion programs at airports serving Seattle-Tacoma, Missoula, Spokane, Salt Lake City, Boise, Medford-Jackson, Sacramento, Omaha, Des Moines, Cedar Rapids, Moline, and Reno.

Dry ice was used in many of the fog modification projects. The seeding agent in most of the precipitation projects was silver iodide.

"Weather Modification Activity Reports—November 1, 1972, to December 31, 1973"—by Mason T. Charak and Mary T. DiGiulian of NOAA's Office of environmental Monitoring and Prediction—describes the projects reported during the period and provides information on their purposes, locations, sponsors, operators, equipment, techniques, and seeding agents.

Top NOAA Officials View Tornado-Ravaged Areas

Her home severely damaged, precious figures remained undamaged, Mrs. Jack B. Richmond of Northfield, Ky., tells Dr. White, Mr. Burke and Dr. Cressman. Like others interviewed, she reported ample warning by the Weather Service.

noaa/update

ERL Seeks Answer:

DO CIRRUS CLOUDS BLOCK SEVERE STORM FORMATION?

Thin, high altitude, ice-crystal clouds called cirrus can cause sufficient cooling at the surface to prevent the formation of regional "hot spots" in the lowest layer of the atmosphere—perhaps inhibiting thunderstorm formation over such areas as the comparatively treeless, sun-baked region of the Midwest's "tornado alley."

In an effort to evaluate this possibility, NOAA scientists are using infrared, remote sensors to study the thermal effect of both natural and artificially produced cirrus cloud decks in an experimental program that began in the spring of 1973.

During the 1973 experiments, which took place over California's hot San Joaquin Valley, a National Aeronautics and Space Administration F–104 jet made overlapping contrails at 40,000 feet, creating an artificial cirrus deck, while the infrared radiometer-equipped NASA 990 jet laboratory measured the earth's before-and-after surface temperatures. These measurements showed a temperature drop of up to 15 degrees Celsius that persisted for one hour after the artificial cirrus clouds were generated.

Dr. Peter M. Kuhn of the Environmental Research Laboratories explains the sun is inhibited from forming hot plumes of air over open flat land by the presence of a cirrus cloud cover at altitudes of 30,000 to 40,000 feet. The layers of ice crystals contained in the cirrus clouds block the large input of solar power over the area, reflecting sunlight back up into the atmosphere. This results in a cooler earth surface temperature similar to conditions which occur when a sweltering hot day changes to more acceptable coolness with the onset of a cirrus canopy.

In their initial results, it appears that certain terrain types are better for hot spot formation than others—plowed fields, sandy loam, dry river bottom, and short stands of grain.

A favorite area for hot spot formation is a plowed, moderately dry field or dark sand area such as the strongly illuminated or high sun angle regions of the Great Plains. Cities, on the other hand, generate hot spots later in the day, when their high heat capacity makes them warmer than the surrounding open, rural areas, which begin to cool near sunset.

While other weather conditions may be more critical in producing strong convective action, the hot surface region and attendant hot spots are important elements in generating the thermal instabilities necessary for severe storm generation, Kuhn says.

Since the 1950's, attempts have been made to link these "furnace areas" to the development of severe thunderstorms. Particularly conducive to the onset of the heavy storms are very hot, cloudless conditions, followed by rapid late afternoon buildup of cumulus clouds, and the explosive progression from swelling cumulus to giant thunderheads and a full-blown squall line.

"If the hot spots are inhibited by preceding cloudiness, then the storm activity should decrease in such regions," the NOAA scientist explains. "Recent satellite observations clearly show on a very large scale, that high, wispy cirrus over an area indeed inhibits severe storm outbreaks, and a clear link to the hot spot-storm relation is established."

Apparently the hot spots form several miles upstream from the actual onset of severe storms, following the morning inversions (in which the atmosphere temperature increases with height) that are typical of the Great Plains summer.

He Costs More Than Caviar:

Meet The Baitworm, Aristocrat Of Sportfish Cash Register

The lowly worm, near the bottom rung of the evolutionary ladder, is a high-priced commodity on many sportfishermen's shopping list. The delectable (to a fish) bloodworm, for instance, fetches gourmet prices at bait shops, running as high as $3.00 a dozen, or over $15 a pound.

Researchers at the University of West Florida, funded by a Sea Grant, believe there is a commercially profitable way to breed and raise baitworms. The results of their efforts could lead to the establishment of a new and thriving industry.

The project is being carried out by Charles N. D'Asaro, a biology professor and leader of a research team at the university's hatchery on Sabine Island near Pensacola. The Sea Grant scientists are studying ways of culturing the lugworm, a marine annelid virtually unknown to all but the most erudite anglers in this country, but an extremely effective natural bait.

Lugworm is a shy creature that lives in a U-shaped burrow about 18 inches deep. While the flavor is very attractive to sport fish, the effort required to dig him up makes him unpopular with fishermen who must find their own bait. The lugworm is, in fact, so unsung that he is offered at few if any commercial outlets in this country.

According to Professor D'Asaro, a single piece of this delicious and durable worm has been known to catch ten fish; a large-sized lugworm (about as long as a man's hand) could catch 30 or more fish, ranging in size from a half to two pounds.

Lugworms—in addition to being an excellent bait—have many biological characteristics that make them ideally suited to aquaculture.

The University of South Florida Sabine Island operation is a rather simple facility which handles all stages of development of the lugworms, limited only in the number of adult worms that can be produced.

D'Asaro's team believes that with controlled conditions, they can raise marketable worms in 120 days. Harvesting the worms presents no problems; they can simply be strained from the substrate.

NOIC TESTING INSTRUMENTS STUDY WAVES

How high are the waves in the ocean? How fast do they move? With what impact do they strike the shore? What effect do they have on weather? Pollution? Coastal structures? Offshore oil platforms and deepwater ports?

The National Ocean Survey is testing instruments which may help furnish the answers to questions that have puzzled man for centuries.

The testing is being done for the Survey through its National Oceanographic Instrumentation Center and its NOAA Data Buoy Office.

NOIC recently tested eight wave-measuring instruments in the Pacific Ocean off Scripps Institution of Oceanography at La Jolla, Calif. All were available items ranging from bottom-mounted acoustic devices to large vertically oriented electrical cables. Richard Ribe, NOIC physicist responsible for the testing program, said the cost of such instruments varies from $500 to $50,000.

Along with the testing of wave-measuring devices, NOAA is experimenting with a wave-measuring system on a deep-ocean buoy.

The system was installed by the NOAA Data Buoy Office on an experimental buoy (EB–13) moored in the Atlantic Ocean in 12,600 feet of water about 300 miles east of Charleston, S.C. The wave parameters measured by the system include the height, period, and width of the waves.

The system has transmitted ocean-wave data regularly since the buoy was deployed last December 10. The measurements are being compared at the NDBO facility near Bay St. Louis, Miss., with ship reports from the area of the buoy position and are being analyzed also on the basis of wind measurements from the buoy. Both the wave-measurement technique and the reliability of the equipment are being evaluated for future use.

Luther Bivins, Acting Chief of NOIC's Testing Division at the Washington (D.C.) Navy Yard, said that the Army Coastal Engineering Research Center at Ft. Belvoir, Va., and the Naval Research and Development Center at Carderock, Md., have continuing requirements for wave-height data.

noaa/update

At Long, Long Last:

People Want To Hear Of One That Got Away

Fish, Shellfish As Viewed From Ohio Counties

What do midwesterners think of fish and shellfish?

Sea Grant researchers at Kent State University, working in Ohio's Summit and Cuyahoga Counties, have come up with some of the answers—at least for one area.

Consumers, they found, enjoy fresh fish better than frozen, but they eat more canned than any other kind. Their only real complaint with shellfish was that they think it costs a lot.

They agreed that fish is an excellent diet food, tastes good, is nutritious, easy to cook, and wholesome—but nutritional value and the diet-food appeal ranked low on their scale of priorities.

Other findings:

A shopper looking for fresh fish will have a better chance of success in larger stores.

Institutional buyers said they were serving as much or more fish than they did five years previously. Retailers, on the other hand, report a decline in fish sales, and wholesalers are selling more frozen fish, but less fresh fish.

Most retailers, wholesalers and institutions prefer frozen fish. They explain that frozen fish is easier to handle, store, and prepare, and suffers less spoilage.

Wholesalers tend to believe that their customers prefer the same kind of fish they, the wholesalers, prefer. Those that prefer to handle frozen fish say that that is what their customers like also; wholesalers dealing in fresh fish believe customers want fresh fish even though in many cases they are talking about the same type of customer.

Wholesalers who prefer frozen fish agree almost unanimously that restaurants, institutions, retailers, and other wholesalers also want frozen instead of fresh fish. Those that prefer to carry fresh fish tend to believe that these same groups (restaurants, institutions, retailers and wholesalers) prefer fresh fish.

The Sea Grant team asked retailers to describe the type of families that buy fresh, frozen, or canned fish. According to retailers, families who prefer fresh fish are: older families; higher or lower, but not middle, income families; Catholics, Jews, Blacks, and foreign-oriented ethnic groups; weight-watchers or health-conscious families. Frozen fish buyers are seen as young, large families at middle- to low-income levels while working mothers or mothers who simply desire the greater convenience of frozen fish. But "all types" of families use canned fish, because of its convenience and because some species, such as tuna and sardines, can be obtained only in cans.

The study grew out of a suggestion by an official of NOAA's National Marine Fisheries Service that if more high-quality fish such as fresh finfish and shellfish could be placed more quickly at Midwestern outlets, everyone from fishermen to consumer would benefit.

The Sea Grant team found that, in the area surveyed, canned fish account for 53.5 percent of the average grocery store's fish sales. Frozen fish make up 39 percent, and fresh fish sales amount to only 7.5 percent.

SATELLITES AID NWS IN FREEZE FORECASTS

Scientists at the National Weather Service Environmental Study Service Center at Auburn, Ala., and the Weather Service Office in Lakeland, Fla., are utilizing data from NOAA satellites in the development of techniques to provide improved freeze forecasts and advisories for the agricultural industry of the southeastern United States. The work is being done in cooperation with the University of Florida Department of Fruit Crops and the National Aeronautics and Space Administration's Earth Resources Offices at Kennedy Space Flight Center.

The thermal scanning sensors of the satellites, which are operated by the National Environmental Satellite Service, provide "at-the-surface temperature" data to the scientists working toward better crop weather analysis techniques. Such data is particularly useful for central Florida, where freezes are uncommon, but affect the economy of the state (and to some extent, the nation) when they do occur.

ESSC Agricultural Meteorologist Dr. S. Elwynn Taylor states that surface temperature distribution is a key factor in the development of improved forecasts and advisories, and that utilization of satellite observations is the most practical and economically sound method of collecting the data.

Satellite data is potentially the key to understanding many environmental factors related to the world's food production, an area of increasing concern, Dr. Taylor reports. Environmental temperatures as well as solar radiation data, both of which can be sensed by satellite borne sensors, are among the most critical parameters determining the success or failure of agricultural production. These data ar significant in determining not only the extent of a damaging freeze but are also useful in predicting and assessing a real crop growth and condition as well as other significant agriculturally related processes.

ERL Acquires COED, New Computer System

A $482,000 contract has been awarded to Modular Computer Systems of Ft. Lauderdale, Fla., by the Environmental Research Laboratories for procurement of a new computer system termed COED (COmmunications and file EDitor) which the company will deliver later this year.

COED, consisting of four small, file-cabinet-sized computers, will interconnect three other computers the Environmental Research Laboratories already have—two Control Data Corporation 3800s and a Xerox Data Systems 940—and may eventually connect the laboratories with the Advanced Research Project Agency's nationwide computer network. It will also store data, allow users to enter new data or change data, and have results printed. COED will allow scientists and computer programmers continued entry of data, modification of programs, and listing of previously calculated results.

Marine anglers of the Atlantic coast soon will be asked to record details of fishing adventures—not only about fish caught but also about the ones that got away.

This summer, several thousand marine recreational fishermen will be asked—by mail and telephone—to assist National Marine Fisheries Service statisticians toward the compilation of uniform and complete records of the annual harvest of marine fish and shellfish.

The agency is set to begin an extensive survey of sport fishing in Maine, New Hampshire, Vermont, Connecticut, New York, Rhode Island, Massachusetts, Pennsylvania, New Jersey, Delaware, Maryland, Washington, D.C., Virginia, and West Virginia. The work will be done by a private data collecting firm under contract to NMFS. In time, the study will be expanded to include all national marine fishing regions. State and private sportfishing organizations have helped NMFS fisheries experts prepare a list of survey questions. After receipt of answers, the Fisheries Service will analyze and publish the findings.

In the first phase of the Marine Sport Fish Statistics Program, 27,000 households will be briefly questioned by telephone to establish a valid mailing list of active saltwater fishing households. Next a more detailed questionnaire will be mailed to a selected sample of several thousand households, querying them on a confidential basis about: how often and how many anglers of what age and sex fished when, where, and how; what kinds of fish and shellfish were caught in what quantity; how the catch was used; and how much time and money were spent on sportfishing activities. As a general rule only about 30 percent of any given mailing list of contacts responds to such questionnaires; therefore, the surveyors will complete another round of telephone calls to non-responders after a specific period of time has elapsed. Thereafter, a mail-and-telephone-call sequence will be repeated every two months to collect the desired data over a calendar year.

Plans call for a continuation of the data-collecting activity on the same general basis through 1976.

* U.S. GOVERNMENT PRINTING OFFICE: 1974—542-776/4

UNITED STATES
GOVERNMENT PRINTING OFFICE
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VOLUME 3 NUMBER 4 OCTOBER 1973

U.S. National Oceanic and Atmospheric Administration

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